Developing technological knowledge in primary school - a teacher-researcher collaboration study

Key words: content knowledge, primary education, teacher-researcher collaboration

Introduction

The purpose of this study is to contribute to the development of the content knowledge of primary technology by explaining and clarifying the meanings of the subject-specific capabilities that pupils are expected to be able to develop through technology education. The study is designed as a learning study and it has both practice-developing and knowledge-generating aims. This paper presents the planning of the study and the preliminary results of its first part.

Background

Praxis-oriented research in collaboration with teachers

Teachers' professional knowledge is largely available as tacit knowledge; the profession lacks a unified and formulated knowledge base, and this fact is seen as problematic (Hiebert, Gallimore & Stigler, 2002). To develop this knowledge base, the professional knowledge must be public and it must be represented in such a way that it can be communicated between colleagues. The discussion has been based on the assumption that teachers' professional knowledge base should be built on university-based research (Bulterman-Bos, 2008). Academic research, because of its generalizability and trustworthy character, has thus determined what counts as valid knowledge, (Cochran-Smith & Lytle, 1999; Hiebert, Gallimore & Stigler, 2002) and teachers have been given the role of receivers and intermediaries of someone else's knowledge. However, educational research has not been sufficient to develop and improve classroom teaching and learning (Hiebert, Gallimore & Stigler, 2002). By valuing practical professional knowledge, teachers have the opportunity of participating in school development and hence in the development of a professional knowledge base for teaching. This also means that teachers' practitioner knowledge is taken into account, for example in identifying the difficulties pupils have in learning a certain content. In that way, research changes the focus to issues relating to teachers' specific problems of practice, i.e., content based on the problems and issues that teachers face in their profession.

School-based Development Research - a few different models

There are different types of models for development research that is closely linked to the object of learning in the classroom. These models have in common that they iteratively and systematically study certain aspects of teaching practice.

In the Japanese model lesson study a group of teachers come together and examine one or a few lessons, so-called research lessons, which they have initially planned together and carefully observed. The teachers then meet to discuss their observations and ideas on how to revise the lesson. Thereafter, they teach the revised lesson and repeat the procedure. The

lessons are thus studied systematically and carefully in order to achieve the goals identified. The lesson study is controlled by the teachers themselves, and the most powerful implication of a lesson study lies in the details of how teachers view their own practice during the course of the study (Fernandez et al., 2003).

In a design experiment, by contrast, the researcher formulates the object of research and creates the lesson plans. A design experiment is always theory-based and consists of repeated experiments in which the teaching or the teaching tools are modified between experiments (Cobb et al., 2003).

A learning study can be considered as a further development of lesson study, or a hybrid of a design experiment and a lesson study, as teachers and researchers together develop the object of learning, and the research lessons are based upon a theoretical framework. The necessity of a theoretical framework for understanding how teachers' actions in the classroom affect students' learning is highlighted by Nuthall (2004). The theory used in learning study is so far the variation theory. A learning study has several aims: first, it aims to improve pupils' learning and to contribute to teachers' professional development by developing their understanding of what it means to know something within a specific topic. An additional aim is the production of new knowledge, which is based on the researcher's interest in exploring the practice.

Technology content knowledge in focus

The subject of technology has a vague sense of what constitutes subject-specific content and the specific capabilities that students are expected to develop by technology education. This ambiguity has implications for the content featured in teaching practice, which often relates to subjects other than technology. Teacher training and teaching experiences of other school subjects seem to have a great influence on the content of teaching (Bjurulf, 2008, Jones & Moreland, 2003). According to a survey carried out by the Association of Swedish Engineering Industries, there is a widespread uncertainty among teachers, especially teachers in primary education, about what the subject of technology is really about and what capabilities the subject should develop (Teknikföretagen, 2005).

Hagberg (2005) reflects on how Swedish research on technology education can become more firmly rooted in the international research community, and argues for content-oriented research. “Research whose aim is to contribute to greater understanding of the key concepts and core areas of the field can be pursued to advantage in combination with development projects that involve teachers in the schools.” (ibid.)

Several scholars argue that research on technology education should focus on how teachers teach and how students learn, and the relationship between teaching and learning (Johnson & Daugherty, 2008; McCormick, 2004), the involvement of teachers as co-researchers is also highlighted (Benenson, 2001). Praxis-oriented development collaborative studies on technology education are not very common, one exception being a design experiment on engineering design conducted in a class with 9-10 year old pupils (Roth, 1998).

Theoretical framework

Variation theory

The variation theory has emerged over many years of research on learning and has its roots in the phenomenographic approach, which was developed at the University of Gothenburg in the early 1970s, led by Ference Marton. A basic assumption in this research approach is that an individual's perception of a phenomenon may be different from the way other people perceive the same thing. However, people perceive, understand or experience real world phenomena in a limited number of qualitatively different ways. In phenomenographic studies such differences are characterized and described in "ways of experiencing something", and the method used is interviews. The qualitatively different description categories are usually ordered in a hierarchy (Marton, 1981; 1994).

Learning always involves the learning of something, a content. This content is called the object of learning and it is the main focus of the variation theory. The object of learning is a capability and has a general aspect, the indirect object of learning, which refers to acts. It also has a specific aspect, the direct object of learning, which refers to content. Learning can be considered as an ability to see something in a certain way, and it involves an awareness of certain aspects of the object of learning. Being able to discern something in a certain way requires variation; one aspect is discerned as a dimension of variation. Variation is therefore necessary for learning, but general variation is not enough, it is variation of the critical aspects that are necessary for learning. Variation thus enables the students to experience aspects that are critical for a particular learning and the development of certain capabilities (Marton & Tsui, 2004). The specific object of learning may be defined by its critical features, i.e. the elements it is necessary to distinguish in order to achieve the constitution of the sentence sought. The critical features must, at least in part, be founded empirically, and they are specific to each particular object of learning.

If we want to give students the opportunity to develop a certain capability, they must experience a certain pattern of variation/invariance. If this pattern occurs in the classroom, there is of course no guarantee that the students experience it. It is possible to experience it, but if it is missing no one can experience it. Students may experience the pattern on the basis of past experience or through a combination of this and what they experience in class. The patterns of variation in a given situation, "the space of learning", constitute the limit of what is possible to learn in a particular situation.

From a theoretical perspective of variation different ways of seeing or experiencing something arise from the differences in which aspects are discerned simultaneously. Variation theory addresses differences in learning and describes the conditions necessary for learning. The development of the variation theory has made it possible to analyse classroom practice and teaching practice with new analytical tools. Variation theory can also be used as a tool in lesson planning.

Method

Learning study

A learning study is a cyclic process of planning and revision and comprises the following steps:

1. Choose an object of learning

2. Pre-test the students

3. Co-plan the lesson

4. Conduct the lesson

5. Post-test students

6. Analyse the lesson and revise it

Steps 2-6 describe a so-called cycle carried out with a teacher and a group of students. The next cycle is carried out in another group of students and with another teacher, etc. In each cycle the lesson is analysed and evaluated in relation to the object of learning and the lesson is revised. By working iteratively with planning, evaluating and revising a lesson dealing with the object of learning, knowledge is produced about teaching and students' learning in relation to this content, as well as content knowledge itself.

The study was conducted in an elementary school, with grades 1-3, during one semester and in collaboration with four teachers at the same school. The participating teachers had relatively long professional experience but their experience of technology teaching differed. The study's first cycle, presented here, involved one of the teachers and her class, consisting of 26 pupils in grade 2 (aged 8-9 years)

Data collection

Meetings with teachers were audio-recorded. Pre-tests were conducted in the form of interviews with pupils in pairs using semi-structured interviews which were documented by video recording and audio separately.

Results

The object of learning

One of the starting points of the study was the content described in the syllabus of the subject of technology for Swedish compulsory school, which will be introduced in autumn 2011. By starting from the new policy document, teachers' participation in the study can be seen as part of the implementation process. Our object of learning was formulated as the capability to identify and analyse technical solutions with opening/closing functions based on expediency.

Pre-test

To identify students' perceptions of expediency of technical solutions, interviews were conducted with all pupils in the class. During the interviews, we talked about and examined some everyday objects in terms of expediency. The objects included things such as a juice bottle, matchbox, zippers and different types of hinges and their opening/closing function. The interviews were transcribed and analysed subsequently using phenomenographic analysis. This analysis aims to identify and describe categories of qualitatively different perceptions of the phenomenon expediency. The following list summarizes the prelimary categories found.

1. Expediency as an appropriate imaginary purpose

I do not recognize the components of a technical solution as part of a larger whole which has a technical function. I imagine based on the objects' appearance, and invent my own purpose for these objects, which is not linked to the function of opening and closing.

2. Expediency as appropriate movement patterns

I perceive expediency as a movement that is visible, such as “pushing the box-motion” when I evaluate the expediency of technical solutions. It does not relate to the technical solution, but only to the physical movement associated with the use of the technology solution.

3. Expediency as user conformity.

I perceive expediency from the user's needs and the situation

a / Myself as a user

I understand expediency of technical solutions based on my own experience of the practical uses of the technology solution. A technical solution that meets my needs is appropriate. The expediency of it is connected to its simple and reliable operation, and to whether it facilitates my life. It is associated with simplicity of use, reliability in use, and problem-solving.

b / Other users

I value technical solutions in relation to other user's needs. There are users other than myself, such as young children, who have other needs that must be taken into account when designing a product.

4. Expediency as something that is dependent on the construction

I understand the expediency of technical solutions based on the requirements of the technical solution in relation to its purpose. For example, an opening and closing device for a fluid has to prevent leakage, which poses special design requirements.

a/ Something that is dependent on the choice of technical solution

The purpose of the opening and closing function determines the choice of technical solution. I can suggest several alternative solutions that meet functional requirements, such as zippers and buttons to open and close the jackets.

b/ Something that is dependent on material

I understand certain properties of materials and their limitations, and suitability of a design to fulfil a function.

c/ Something that is dependent on the form

Structural form affects how well the function is fulfilled, for example consider a small zip compared with a large zipper - they have different uses for different purposes.

d/ Something that is dependent on the interaction between different components

I have identified how different components interact in the design to fulfil the function.

Conclusion

The preliminary result of the phenomenographic analysis of the pre-test showed the students' qualitative differences in the experience of expediency of technical solutions. With this result as a starting point, critical aspects of the object of learning are identified which will be the basis of the lesson plan.

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Abstract

This paper presents a teacher-researcher collaboration study on the development of specific content on the subject of technology in primary school. The study is conducted as a learning study, a model inspired by the lesson study model. The object of learning has been formulated by taking the goals and the subject content described in the Swedish technological curriculum as a starting point. The specific capability explored focuses on the identification and analysis of technical solutions in relation to their expediency. During the study, researcher and teachers work together by planning, observing and revising the lessons in an iterative and systematic way in order to develop content knowledge and improve the teaching. The study aims to improve technology teaching practice and enhance professional development through engaging teachers in the research process. This paper presents the planning of the study and the preliminary results of its first part.