Hands-on material in technology education: the first cycle of a learning study

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Abstract

The aim of this paper is to describe the first cycle of a learning study in technology education, using a hands-on material, in a Swedish preschool class, i.e. pupils at the age of six. The study was conducted by three teachers and two researchers during fall 2011. Within a learning study, the pupils' learning is in focus in order to find out the opportunities and obstacles in teaching. The teachers and researchers are working in close cooperation when planning, observing, analysing and revising a specific lesson in which a specific learning object is dealt with. The learning study described in this paper, was carried out with starting-point in the revised Swedish curricula, launched in fall 2011. The results show that the use of a hands-on material may obstruct the view of the learning object, if the pupils are not able to manage the material. The results also indicate that an unsupported practical oriented task could prevent the intended learning object to appear for the pupils.

Introduction

Current research shows that a learning study is a vehicle to enhance pupils' learning (Lo, 2009; Marton & Morris, 2002; Marton & Tsui, 2004). When conducting a learning study the focus on pupils' learning is of central importance. How does the teaching facilitate, or prevent, the possibilities to learn? Through conducting the learning study our intention was to 1) implement a learning goal in technology from the new syllabus implemented in Sweden during fall 2011 (Skolverket, 2011) and 2) improve teaching and thereby enhance the pupils' possibilities to learn a specific learning object. The indirect object of learning in this study was *the ability to use strength in own constructions* (bridges) and the indirect object of learning is *framed structures*.

Moreover, both pupils' and teachers' knowledge as well as the researchers knowledge about the teaching, learning and understanding of the chosen learning object were expected to improve during the learning process of working as a team in a learning study.

In this paper we aim to describe how the first cycle of a learning study was carried out in a pre-school class. This is the first learning study of three, to be conducted in three different age-groups, in order to study the progression of a learning object in the new syllabus for technology education implemented in fall 2011.

Learning studies

An overall purpose with the learning study approach is "to generate data that enable us to establish the relationship between teaching and learning" (Pang & Ling, 2011), i.e. "to help teachers to help students learn the object of learning" (Ling & Marton, 2012 p. 8). Lo (2009) gives an overview of the development of the learning study approach in Hong Kong as from the late 1990s, as the very first learning study was carried out in Hong Kong in 1999. The first ones were conducted in mathematics, Chinese language and English language, but cover most school-subjects today as well as various levels of the school curriculum. Those learning studies show the significance of the specific classroom research model, which can be summarized as follows:

The teacher learning takes place in their own practice, where the aim is to help the pupils to learn what is intended to learn and "the learning study always takes the object of learning as the point of departure" (Lo, 2009 p. 177)

Since the teachers work in close cooperation with researchers, and thereby work as researchers who generate knowledge about their own practice, "the theory-practice gap, which has led to the failure of many attempts to change classroom practice, disappears" (Lo, 2009 p. 177).

The learning studies have resulted in pupils' improved learning (Ling & Marton, 2012). The learning studies have also contributed to the teachers' professional development and the learning of researchers (ibid.). Like in Hong Kong, several learning studies in Sweden have focused on (the Swedish) language (Gustavsson, 2008) and mathematics (Kullberg, 2010; Runesson, 1999; Wernberg, 2009) in compulsory school, but also in biology (Vikström, 2005) and technology (Björkholm, 2011) in compulsory school and in economy in higher education (Rovio-Johansson, 1999). The results of these studies show the similar result as in Hong Kong, i.e. that the variation of the critical aspects plays a crucial part in whether the pupils learn what the teacher intended them to learn (Lo, 2009; Marton & Morris, 2002; Marton & Tsui, 2004).

The predominant studies concern mathematics and language, and thus the research overview points at a need of conducting more learning studies in other subjects, like for example technology in the Swedish compulsory school.

Method

In the light of the results from the body of current learning studies, there is an assumption that teaching will improve and the pupils' possibilities to learn thereby will enhance when carrying a learning study through. Therefore, our intention is not to examine if the teaching will be improved, but rather to examine in what way a learning study may be implemented in technology education, using a hands-on material. The hands-on material used in this study was *4DFrame*, a teaching material, which was invented in South-Korea about ten years ago (Hedkvist Manninen, 2010). The material contains of a variety of connectors and tubes, which are combined to polygons, or any other structures (see for example figure 1), and different kinds of models with moving parts, like cars, airplanes, windmills and waterwheels.

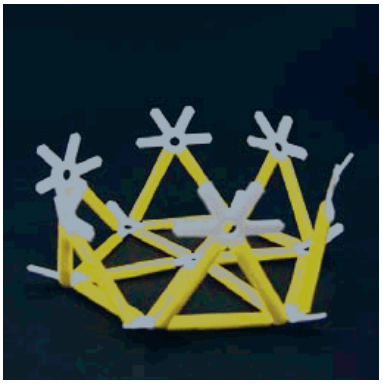


Figure 1 *4DFrame* structure

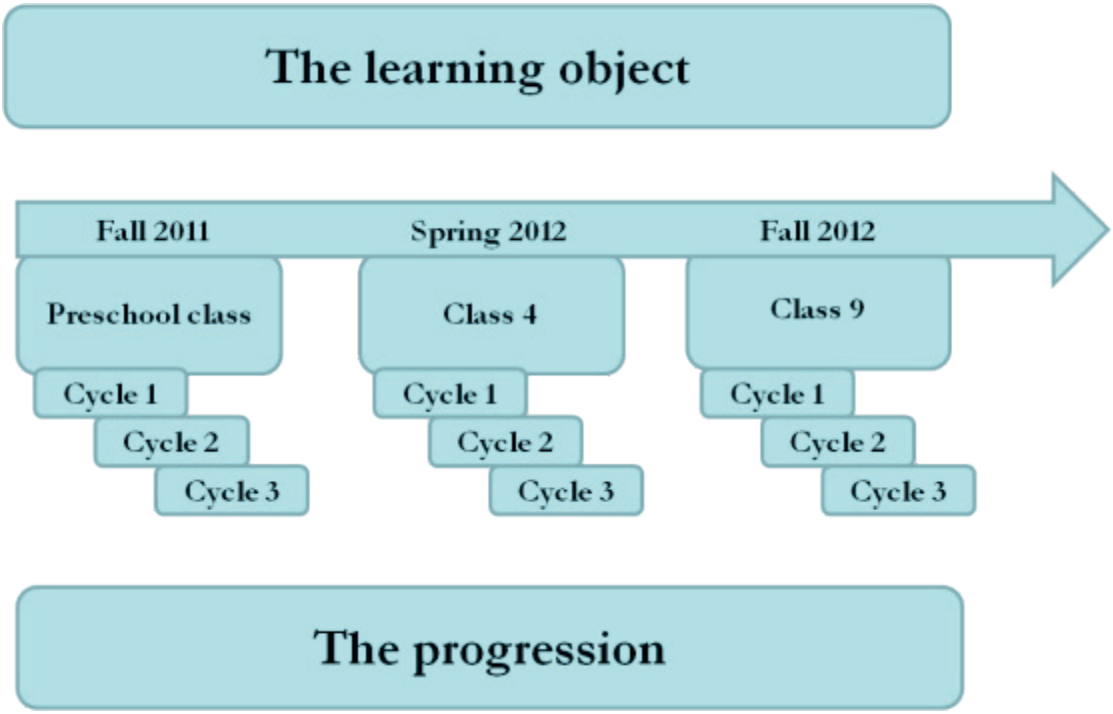
The teachers in this study have used *4DFrame* in their teaching for about two years and have both received training in the material and also themselves been in charge for in-service training.

Pang and Ling (2011) emphasize two important elements in the learning study approach. The first one is the distinct focus on the object of learning, i.e. to identify what the pupils should learn and the critical aspects that they must discern in order to understand the intended object of learning. The learning object has two aspects, the *direct* and the *indirect*. The *direct* object of learning is the content intended to learn and the *indirect* object of learning is a certain skill, value or capability that the pupils are supposed to develop.

The learning study approach follows the steps typical of an action research process (Pang & Ling, 2011). The different steps we have conducted are as follows:

- defining the learning object
- finding out the pupils' experiences of the learning object
- designing the research lesson(s) of the learning object
- teaching the research lesson(s)
- evaluating the research lesson(s) and identifying the pupils' learning problems
- adjusting the research lesson(s) based on the results (compare e.g. Marton & Ling, 2007).

These steps, i.e. the learning study cycle may be repeated in as many groups of pupils as necessary in order for the teachers to find out the necessary conditions for the pupils' discernment of the critical aspects of the learning object. In our project we are going to conduct three learning studies in three different classes (see figure 2) with the overall purpose to examine in what way learning studies may be implemented in technology education. In this paper *cycle 1* in the *preschool class* is described (see the arrow in figure 2). As figure 2 shows, each class is divided in three groups of pupils.



Figur 2 The timeline of the project

Data for this study was collected through a videotaped research lesson as well as pre- and post-tests. The pre- and post-test involved the pupils to build models of bridges of the hands-on material *4Frame,* sitting together in a classroom, followed by individual interviews. In our learning study we conducted three cycles, and in this paper one of them is accounted for, including seven pupils.

Results

The learning study followed the different steps described above and the following section describes the realization of the first learning study cycle.

The indirect object of learning in this study is *the ability to use strength in own constructions* (bridges) and the indirect object of learning is *framed structures*. The focus on these objects of learning was a result of the reading of the new steering document. The chosen objects of learning was also a result of the teachers' earlier experiences of pupils' difficulties in building solid constructions in general, but with *4Dframe* in particular. Since they are working a lot with fairytales in the preschool class, it was decided to frame the learning object within the story about *The Three Billy Goats Gruff*. The pre-test comprised to individually build a bridge of *4DFrame,* to the goats, and try the *strength* by hanging a weight on the bridge (see figure 2).

Before the pre-test the teacher read the story about *The Three Billy Goats Gruff* to the pupils and ended the story when the goats had walked over a bridge to graze on a meadow with green grass. She told them that there had been an accident, the bridge that the three goats had to walk over to come back to their home had broken, and invited the pupils to help the goats by, individually, build a bridge of the hands-on material *4DFrame*.

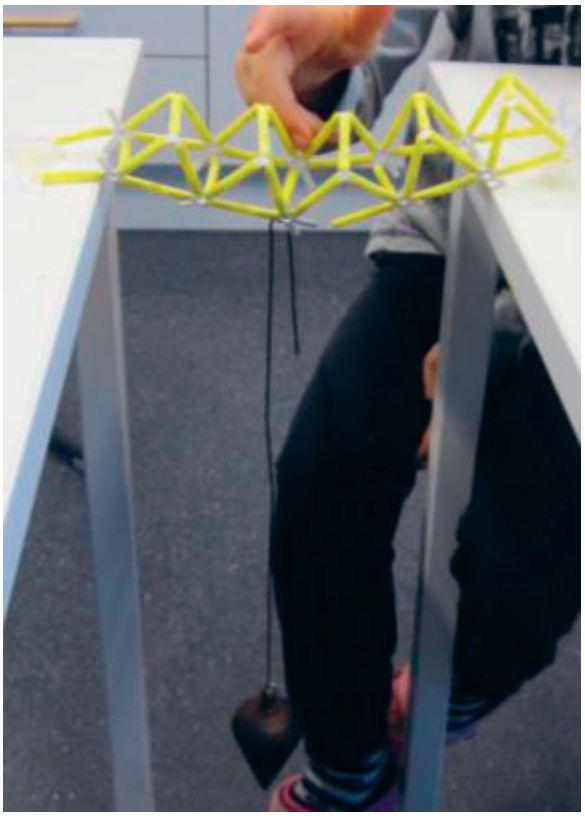


Figure 3 The solidity of the bridges were tested by a weight

When all pupils had finished their bridges, individual interviews about their constructions were conducted. These interviews constituted the pre-test and aimed at revealing pupils' conceptions about the chosen learning object. Consequently, in the pre-test we asked the pupils questions about their use of geometrical objects and if they knew what framed structure is and they tested the solidity of the bridge with a weight (see figure 3).

When analyzing the interviews we found that the pupils had difficulties in discerning the geometrical objects as crucial for strength. Therefore, the difference between a triangle and a quadrilateral was chosen as a critical aspect to focus on in the research lesson, that was taught three weeks after the pre-test.

During the research lesson the teacher built a framed structure (triangle) and a square of *4DFrame* and contrasted the strength of the two geometrical objects in two different ways, by:

1) moving the tubes back and forth – the tubes at the framed structure hardly moved, but the tubes in the square did
2) hanging a weight that showed that the framed structure did not change shape, whereas the square did.

The teacher encouraged the pupils to stand on the floor with the legs wide open, so a framed structure was formed of the legs and the floor, and the arms at their hips so there became two more framed structures:

> *Let us pretend that the wind blows.* (They blow with their mouths.) *And now you try to keep your balance and that is working great when you are standing like this. Maybe we are in a boat, and the boat is rolling back and forth, but we are able to keep the balance.*

Then the teacher contrasted the framed structure with a linear form, by asking the pupils to put their legs together:

> *If we are standing like this* (she put her legs together) *and letting the arms hang downward, and then the wind blows and the boat is rolling.* (The teacher and the pupils tipped over, some of the pupils even fell on the floor.)

Directly, after the research lesson the pupils were asked to build a new bridge followed by an interview. One of the pupils was absent at this occasion, so there were six pupils. When looking at the bridges it is obvious that the pupils rather made variants of their first bridges (see figure 4), than applied the experiences from the research lesson about framed structure. Notwithstanding, their first bridges were not simultaneously available until they had finished their second one.

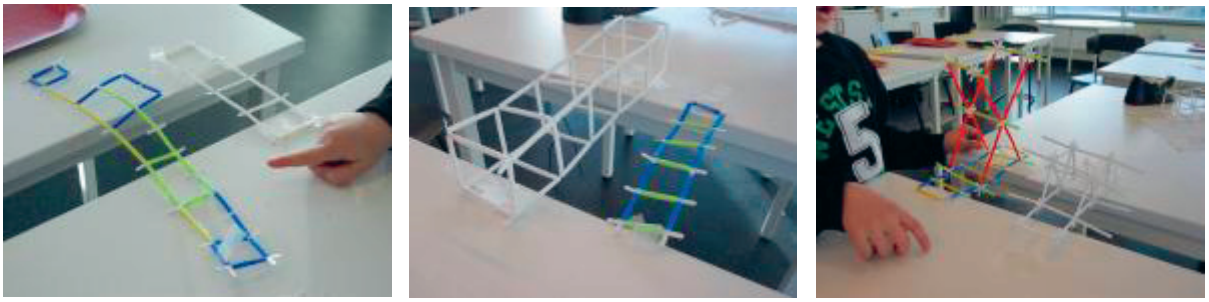


Figure 4 Colored bridges from pre-test and white bridges from the post-test.

The pupils explained their thoughts about their second bridge as follows:

> *I built such a bridge last time too, I built in a similar way.* (Pupil 2, P2)

> *I wanted to build like last time.* (P4)

Those excerpts show that the pupils had their first bridge in mind, when they built the second one. There were also examples of ad hoc constructions, as the following excerpts show:

> *I just took some connecters.* (P3)

> *I don't know why it became as it did.* (P5)

One of the pupils said that *I just thought, I wanted to build like this* (P1) and another one explained that the new bridge had sides and a roof, since *it* [the bridge] *becomes more solid of the side and the roof* (P6).

When analyzing the research lesson and the post-test, we noticed that how the pupils had connected the *4DFrame* material often was more important in the test, than what geometrical objects they had used. Sometimes an expected stable construction broke, because they had not put the pieces together properly.

Discussion and conclusions

The analyses of the data material and the discussions we have had in the team have contributed to a great extent when it comes to examine our own teaching. The pupils' results in the post-test showed that there were no obvious connections between the lesson and the building task for the pupils, which supports the idea of repeating the learning study cycle in order to "helping teachers to help students learn the object of learning" (Ling & Marton, 2012 p. 8).

The teaching in the Swedish preschool classes follows the national curriculum, but the aims for the pupils to reach are not stated before class 1. This means that the pupils in this study are not used to be taught in this goal oriented way as in this learning study, which may have influenced the results. Nevertheless, there are mentionable findings from the first cycle. An important knowledge, obtained from the first cycle, is that the hands-on material, used in this study, added a dimension that prevented the understanding of framed structure, since the pupils needed to be able to handle the material properly first. Furthermore, since the results from the post-test from the first cycle were depending on how the pupils had connected the building material, than on what shapes they used, we saw that it was not possible for them to reach understanding of the intended object of learning before they could handle the material. Thus, our conclusion is that when using hands-on material in teaching, time is needed to be able to manage the material, before focusing on the intended object of learning. The handling of the hands-on material will otherwise obstruct the view of the learning object.

Furthermore, our study also indicates that the practical oriented task obstructs the view of a specific learning object, since the pupils rather made variants of their first bridges, than applied the experiences from the research lesson about framed structure. Does this mean that an unsupported practical oriented task could prevent the intended learning object to appear for the pupils?

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