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Making meaning of illustrations

- A study of primary school students and affordances in mathematics textbooks

Introduction

Education has a long tradition in the use of illustrations of different types such as pictures and models, posters showing flowers in sections with their stamens and pistils or the cow´s four stomachs for example. The aims of the illustrations are to make it easier and to clarify for the students (Eriksson, 2008). But is that really the case?

We live in a visual world and the ability to read illustrations are today of great importance. What is more, the mathematics education is a textbook controlled subject. Little has been written about how students make use of illustrations in mathematics textbooks, especially concerning younger students. Research on this subject is therefore of great importance in the world at large.

Researchers within the field are divided whether illustrations facilitates for the students or not. There are studies showing that illustrations do facilitate learning (Arzipe & Styles, 2002; Levie & Lentz, 1982) as well as there are studies showing that illustrations can complicate learning (Eklund, 1990; Holmberg, 1990; Watkins, Miller & Brubaker, 2004). When it comes to students handling illustrations in mathematics textbooks little have been written, especially according to primary school education. Jellis (2008) gives a contribution to the field in her thesis work, though. A conclusion of her work is that students pay great attention to illustrations in mathematics textbooks and that it is hard for the students to decide whether a illustration is relevant for solving the mathematic task or not.

Aim

This paper reports on a study of illustrations in mathematics books in primary school (Norberg, 2014). A textbook analysis and observations of seven-year-old students making

meaning of illustrations in mathematics textbooks were made. The illustrations have delimited to the area of subtraction. The samples of area are made out of two reasons: first because subtraction is a central content in primary school mathematics and secondly because I in my former work as a primary school teacher discovered that the students often named subtraction as "difficult", and addition as "easy". This made me curious and interested in what could be the cause of that. *This paper aims to discuss illustrations in mathematics textbooks. How do students make use of illustrations?*

Theoretical framework and analyze tools

The empirical material was analyzed according to two different analysis tools: *affordances* (Gibson, 1986) and *subtraction situations* (Fuson, 1992). I will now give a shortly description of these two, starting with affordance. Affordance out of Gibson´s ecological psychology (Gibson, 1986) focuses on the interaction between human and her environment and on opportunities for actions. The fish finds an affordance to breath in water while the human don't. A chair provides an affordance to be something to sit on it for the human but not for the fish (Gibson, 1986, s. 36). Linderoth (2004) describes affordance as the gap that exists between the two pieces in a puzzle that fit together and where the affordance only exists as a relation between the individual and the environment

After this, a description of subtraction situation will be presented out of Fuson (1992). Subtraction is the inverse arithmetic operation to addition. A common description of subtraction is that it is about removing objects from an amount or that something decreases (Löwing, 2008). For example: Lisa has three apples and gives one away and then she has two apples left. But this explanation of subtraction is a simplification. To take objects from an amount is actually only *one* possible action in subtraction. A subtraction situation could also include a comparison between two different amounts, the difference, for example: Lisa has three apples and Deco has one apple. Lisa has two apples more than Deco (or: Deco has two apples less than Lisa). Fuson names the two subtraction situations: *Change take from* and *Compare.* Fuson also describes a third subtraction situation, *Equalize,* which is explained as a combination of the other two subtraction situations. In a *Equalize* situation two amounts are compared and the operation is made with either a *Change take from* ore a *Change add to* operation.

Methodology

This paper proceeds from a master thesis, which investigated how subtraction is illustrated in mathematics textbook in Swedish year one (seven-year-old students) and how students

make use of illustrations in mathematics textbooks. This paper focuses on the second part of former description.

Video observations from twelve students who, in pairs, discussed five selected illustrations were made and the parent´s permissions were gathered. During the video observation the researcher's role alternated between an observer and a participant through interview-likely-conversations. During the analysis, the researcher´s role has been strictly the observers, though. The camera was placed on a camera tripod a little bit above the students so that the children's faces, their pointing fingers and the illustrations were clearly shown. A microphone was placed on the table beside the children and the researcher is shown in profile. The illustrations were copied in color directly from the textbooks. The researcher partly observed and partly participated, with an aim to understand the students acting, further more. After the students were asked if they wanted to participate in the study the students firstly got to look and talk about the illustration without the researcher´s involvement. All names used in the paper are fictitious. The survey was conducted in accordance with the Swedish Research Council's ethical principles in the humanities and social sciences, which have four main demands: according to information, consent, confidentiality and utilization.

How students made meaning of illustrations

The result shows that the students need to discover both required subtraction situation as well as affordance in order to solve the task as indicated. The students in the study sometimes do that and sometimes they don´t, both considering affordance and subtraction situation. One example of this is an illustration which shows two brick towers in different heights, one brick tower with seven bricks and the other with five bricks. Robin and Love says that there were seven blocks in the tower and then two blocks fell down and now there are five blocks left in the tower: 7-2=5. They saw an affordance of *Visualizing a course of event.* This is mathematical correct, but not the subtraction situation that was meant to be shown according to the instruction in the textbook. The students needed to see an affordance of *Tool for calculation* and use the illustration to perform the calculation: 7-5=2 in order to solve the task in an intentional way, and by that practice subtraction *Compare*. So even when illustrations are meant to show subtraction *Compare* it is not certain that the students discover that and the consequence of that is that the students won´t meet the different subtraction situation in the extent that they could. In addition to this it is worth reminding that subtraction *Compare* was strongly underrepresented, and therefore of great importance that the students get every experience of Compare situations, when possible. If the students discover other affordances and/ or subtraction situations, that influence how they make use of the illustration and they might most likely practice something else than what was supposed to be lectured through the textbook. It is therefore important that students aren´t left alone to handle the illustrations.

Aside from the difficulties discovering the subtraction situation and the affordance that is inquired to discover in order to solve the task, the students show difficulties in knowing, when one illustration ends and another illustration begins. Sasja and Noel gives an example of this when discussing an illustration containing three pictures showing a girl eating cookies. Sasja means that the calculation is: 6-1=5, because the girl has five cookies plus one in her hand meanwhile Noel thinks: 5-3=2 is correct. Sasja sees the two first pictures as one picture, as if they are happening at the same time while Noel sees three different pictures. This leads to different mathematical operations, both mathematically correct. It is therefore important that the teacher is aware of how the student reasoned when solving the task. The teacher thus needs to have a dialogue with the student in order to grasp the students underlying thought.

Students also show example of reading more information into the illustrations than the illustrations are meant to mediate, which I now want to exemplify with Mattis´s argue about that a girl in the illustration are eating more than one ginger bread cookies by saying: "Because you can´t get that full mouth by just eating ONE cookie". Another student, Isa, notes cookie crumbs in the illustration and establishes that this indicates that there were 6 cookies at first, not 5, as the other student claims. These examples shows that handling illustrations could imply difficulties for the student concerning what information in the illustration she is supposed to pay attention to and what information that can be disregarded.

Several of the students link their own experiences to the illustration. Own experience of what the illustration is showing, increases the opportunity to solve the task. An example of that is when Robin is looking at an illustration showing two weigh bowls. The two bowls contains different amount of identically looking marbles but the weigh bowls are still balanced. Robin notices the impossibility in the illustration and says: "-Strange, look (and points at the two weigh bowls) this isn´t right, these two cannot lift these four up. This one should be up and this one down (points at the two weigh bowls again)". So, students own experience can be helpful while solving mathematic tasks in the textbook.

The analysis also shows example where the students are able to solve the mathematics task without illustration, but fail when the same type of mathematics task is presented along with an illustration. Yin and Charlie will provide example of that. The students are shown a page from a mathematics textbook which shows apples and apple snufkins. On the bottom of the page there are similar mathematics tasks as the ones that are illustrated. Charlie starts the conversation about these illustrations by looking at the mathematics tasks in the bottom of the page and quickly and correctly solves the tasks. But when the two students after that look at the illustrations Charlie says: "The apple snufkins means minus. So, eh, two apples and one snufkin. That´s two minus one iiiis, one." The students look at an illustration showing two apples and one apple snufkin. The affordance that the students need to discover in order to

solve the task is the affordance of *Visualizing a course of event*. Something has happened: first there were three apples, then someone ate two of them and now there is only one apple left. Instead, Charlie discovered the affordance of *Tool for calculation*. He used the apples and apple snufkins as tools which he translated into numbers. A conclusion of this is that Charlie knows the math´s, it´s the illustrations that cases trouble here.

Conclusions

The teachers are responsible to assure that the textbooks have good standards. Apart from that, teachers relies on that the textbooks conforms to the curriculum according to Englunds study (1999 & Skolverket 2003), which only partly prove to be true according to a study made of Johansson (2003). Säljö (2010) describes that textbooks are derived out of what school need but textbooks also creates conditions for school. The textbook can thereby be understood as something accommodative on the one hand and something containment on the other hand. This bisectional function can involve difficulties according to the definition of the textbooks role in teaching. In addition to this, the mathematics teaching is a textbook dominated subject (Bremler, 2003; Johansson, 2006; Skolverket, 2003 & 2006; Taflin, 2007) which makes this even more important to discuss in order to create as good learning conditions as possible. This is something that I will continue with during my PhD studies.

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