Using activity theory as a didactic design tool in math teaching – possibilities and demands

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Todays issues

- teachers' and researchers' efforts to expand students' possibilities to learn a specific content using activity theory as a tool in didactic task-design.
    - the relation between teachers and researcher in different interventional research projects and
    - our struggles to develop useful didactical design tools from the principles of activity theory – as a grand theory - on the other

Develop research and collaboration between teachers and researchers. Five aspects to consider:

1. What is the main object of the project (teachers learning or students learning)?

2. Who takes the initiative and the defining of the problem (the teachers, the researchers, the teachers and researchers together or some one else)?

3. Who suggest the solutions tested (the teachers, the researchers or the teachers and researchers together)?

4. Who masters the theoretical tool used (the researcher, the teachers or both the teachers and the researcher)?

5. What kind of division of labour is established (is it asynchronous or complementary)?

Three sections

- Firstly; examples of three developmental research
  projects
  - The Farsta project (2004-2006)
  - The Botkyrka project (2009-2010)
  - The Lidingö Project (2010-2012)

- Secondly; the relation between teachers and researchers
  exemplified by the Lidingö project

- Thirdly; issues related to teachers' role in research and the need
  of developing didactical design tools at an intermediate level.

The Farsta project

- Researchers: Ingrid Carlgren, Seth Chaiklin, Inger Eriksson & Viveca Lindberg.
- Two teams of teachers: 2004 teachers in grade 1-6 and 2005 teachers in grade 7-9.
- The issue: Development of teaching in relation to the long term goals in the Swedish national curriculum.
- Guiding principles: Davydov's Developmental teaching.
- Core idea: the historical analysis of the content to be known and to design a teaching sequence that would make this kind of knowing available for the students.

The five aspects

	Object of the R&D-project	Definition of problem by	Solution developed by	Theoretical tool mastered by	DofL
Farsta (design based & Davydov)	Teachers learning – curriculum	The re-searchers	The re-searchers	The re-searchers	Asynchro-nous

	Object of the R&D-project	Definition of problem by	Solution developed by	Theoretical tool mastered by	DofL
Farsta (design based & Davydov)	Teachers learning – curriculum	The researchers	The researchers	The researchers	Asynchronous
Botkyrka (learning study & variation theory)	Teachers learning – Learning study	The teachers	Collaboratively	The researchers	Asynchronous

The Lidingö project

- The first step – lesson study
- Questioning introductory math-teaching
- Interest in the Davydov curriculum

Development of mathematical thinking – expanded tasks in primary education

- The issue: how to qualify students' math learning, example algebraic reasoning and the understanding of the equal sign.

- Guiding principles: The Davydov curriculum and Learning activity.

- Core ideas: the development of key-tasks that can create a need and a desire for participating / knowing more (i.e. understanding the equal sign). Making a math activity available for the students work.

Key-tasks

- A key-task
  - is a task that has rich possibilities to allow students' to participate in an math activity where their knowing gradually could develop (Leontiev).
  - is a didactical starting point. How the task have to develop is related to what the students do or don't do (Matusov).
  - has the potential to become a learning task as described by Davydov (2008).

Learning activity

- A learning activity is not only a reconstruction of knowledge historically developed in society but also the reconstruction of, as Davydov says:

  historically formed capacities *(reflection, analysis, and thought experiment) that are the basis of theoretical consciousness and thinking. (Davydov, 2008: 117)*

Developing algebraic thinking

- By developing number from the measurement of quantities, Davydov's curriculum also breaks with the common practice of beginning formal mathematical study with number. Observing that culturally and in individual development, the concept of quantity is prior to that of number, he indicted the rush to number as a manifestation of ignorance of the real origins of concepts /…/. (Schmittau, 2005: 18)

The dice task – a game

- The students where presented the sign for "less than" **<** and they were expected to place their throws with two dice so that the sign told the "truth".

- Assumption: sooner or later some of the students will throw a double. This would be a given situation for discussion.
  - Can we use the sign "less than"?
  - What shall we do now?
  - Is there another sign that we can use?

Surprise!

- The students' responses to the teacher's questions were unexpected!
    - Can you use the sign "less than" now?
    - No!
    - Well, what shall we do now?
    - We throw again!

- One of the student suggested that they could use another of the "less than" sign but draw it the opposite way **< >**

- Not until the second group of students two students said that they know a sign for showing equality – the equal sign!

The King's servants

- The King's servants were paid with gold sand and fine oils.

- The servants where suspicious if they really where paid equally.

- Marianne adjusted Dagmar Nauman's (1986) task to prompt a need of deciding equivalences as well as un-equivalences.

The third key-task: *Equalities, A+B=C and Cuisinaire-rods*

$$A+B=C$$

Algebraic expressions with the help of Cuisinaire-rods

- The rods allowed the students to place and express different equivalences
- They used letters to name the rods when they represented different algebraic expressions.
- A=B+C or other letters
- Wiliam used W to denote one of the rods in his expression.

1cm
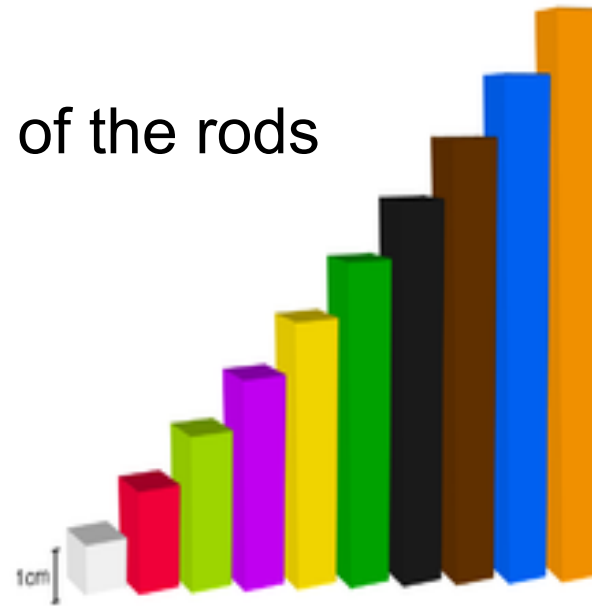
Concluding remarks

- The project was in many aspects realized as a genuine collaborative project where the teachers and the researchers participated with a common object – the students' learning.
- With reference to Engeström (2008) the project may be described as a formative intervention: neither the researcher nor the teachers had any answers to implement or to try out.
  - Marianne continued developing the third key-task during the spring.
  - Further, she has tested the dice-task in other classes with more or less the same experiences as in her class.
  - And, we have written a common peer reviewed article that is published.

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Lidingö (design based research & Davydov)	Students learning – equal sign	Collaboratively	Collaboratively	The researchers and the teachers	Complementary

Subject specific didactical research – a joint activity?

- Today teachers are under a lot of stress.

- The teachers are blamed for different failure but they are not given the power and tools to develop their own profession – their didactical work.

Tools for subject specific didactical design

- So if we want to use activity theory AND learning activity as a research tool we need to develop some intermediate didactical theoretical models
A model that helps the teachers to
  - define the meaning of the knowing we are aiming for and conduct in-depth analysis of the knowing we aim for like finding a germ cell or a specific practice
  - focus upon students' actual experiences and mastering
  - uses learning activity as a guiding principle when designing content rich activity (or practices)

Thank you for your attention!