(Early) Algebra in Primary School

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Overview

• Introduction project
• Working with a hanging mobile
• Student work
  • On paper
  • Movies
• Conclusions
Beyond Flatland Project

**Aim:** introduce more mathematical activities in primary school

→ Stimulate higher-order thinking (HOT)

**Focus:** grade 5 students

Three **mathematical domains:**

- Dynamic Data Modelling (graphing change)
- Probability
- Algebra
(Early) Algebra

• The Netherlands teaching algebra starts in secondary school

• However, there is much evidence that it can successfully be implemented in the primary grades (e.g. Kaput et al., 2008)
  – E.g. 10-year olds solving linear equations with unknowns on both sides of the equal sign (Brizuela & Schliemann, 2004)
    
    \[ 2T + 7 = T + 20 \]

• EARLY algebra

• Does not mean: teach formal algebra only at younger ages
Early Algebra

• **Research question**: How can primary school students’ algebraic reasoning be fostered?

To answer this question we have developed a teaching sequence for Grade 5 of six lessons on early algebra.
Development of Teaching Sequence: Focus on equations

- Broad domain of algebra, chose to focus on *equations*
- Informal algebra
- More specifically: use context-based equation-like problems as starting point instead of formal equations

10Y = 2X
X = 2Y + Z
Z = .... Y?
Development of Teaching Sequence: Embodiment Theory

Offering students **bodily experiences** with a certain (mathematical) concept, can contribute to a deeper understanding of this concept.

E.g. offering perceptuo-motor experiences
Assignment in groups

- 5 groups

- **Assignment**: Discover what things can be done while keeping the hanging mobile straight

  ➔ Make a poster of your findings (write/draw/...)
Discussion of findings

What things can be done while keeping the hanging mobile straight?
Some things we thought of:

• Change L/R

• Change order of bags on one side
Some things we thought of:

- Add (similar) bags on both sides
- Add bags (based on ratio) on both sides
Some things we thought of:

• Take away (similar) bags on both sides

• Take away bags (based on ratio) on both sides
Some things we thought of:

- Replace bags of certain color by another color (based on the ratio)

- ...
Discussion in groups

1. Which algebraic principles/concepts/strategies can be found in this task?

2. In what way does embodiment play a role? Can you think of a concept we are trying to embody?
Algebraic concepts/principles: what we thought of

- Equality / equivalence

- Restructuring principle:
  - Change L/R side
  - Change order of bags on one side

- Isolation principle:
  - Take away similar bags
  - Take away bags based on ratio

- Substitution principle:
  - Replace bags of certain color by another color

- Context-based notations

- ...?
Embodied cognition approach

- Offering students **bodily experiences** with the concept of **equality** can lead to a deeper understanding of the concept (cf. Núñez, Edwards, and Matos 1999).

- Constantly trying to keep the hanging mobile in balance.

- Builds on the **balancing** experiences most students already have in everyday life.

- Understanding the concept of equality is crucial for solving equations (e.g. Greenes & Findell, 1999) working with the hanging mobile could provide a **foundation for developing algebraic reasoning**.
Student work

So far:
1. In what way can algebraic reasoning be elicited in primary school students?
2. Which algebraic strategies are elicited by letting students work with the hanging mobile?

From this point on: what algebraic reasoning do we see when students work with the hanging mobile?
Movie 1: working with the hanging mobile
Movie 2: working with the hanging mobile
Movie 3: classroom discussion
There are unlimited possibilities when you stick to these rules:
• There must be three times as many whites on the one side, as blacks on the other side
• There must be the same number of reds on the one side, as reds on the other
Poster 3

We put the same number of bags on both sides

We turned one black bag into three white ones

We hebben bij allebei de kanten even veel balletjes gehangen.

Van de 1 zwarte balletje we hebben 3 witte gemaakt.
Posters 4 en 5
There are unlimited possibilities when you stick to these rules:

- There must be three times as many whites on the one side, as blacks on the other side
- There must be the same number of reds on the one side, as reds on the other side

We put the same number of bags on both sides

We turned one black bag into three white ones
From this point on...?
Literature

Thanks a lot for your attention!
Do you have any questions??

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