Constructing Dienes Blocks With Magnetic Cubes – A Preschool Game Named Klickinary

Intriguing Improvement of Number Representation Learning

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Abstract

The purpose of this approach is to enhance the idea of Dienes multibase arithmetic blocks with even more intriguing elements. In the proposed counting game preschool children are encouraged to construct the Dienes blocks themselves by bundling magnets. First results in the field – on a very small sample – are very promising. The algorithm can be handled even at the age of 3. Correct numbering for base two and other bases is easily reached by almost nonverbal means. Moreover, high intrinsic motivation was observed with the children insisting to play the game again.

Keywords and Phrases: Dienes, multibase blocks, construction game, early numeracy

1. Context

Dienes (1960) theories and numerous inventions of concrete manipulatives for learning mathematical concepts, including multibase arithmetic blocks, had been highly influential since 1960 in research and in school practice. Base ten blocks are still in educational use today despite a hard backlash from the mid-1970ies.

Dienes' intention behind the multibase blocks, as well as his many other games, was to introduce deeper mathematical structures in a playful manner to foster abstraction and generalization. In particular, Dienes blocks address representation of and operations with numbers in context of the place value system.

This research proposes an extension to the multibase block approach with even more intriguing elements. The child is confronted with an arbitrary number of magnetic cubes and asked to play a 'game' following standard block bundling rules leading to the respective multi-base blocks thus resulting in the corresponding number in the respective numbering system.

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2. The Game

In his memoirs Dienes (2003, p. 435f) describes a spontaneous visit in a school near Zürich where he pretended to be a space traveler from Mars where 'people never count beyond three'. Together they counted the children in that class by recursively counting up to three leading to the ternary number. After the kids 'taught' him to count up to four, they counted the corresponding quaternary number. As a primary school student in the early 1970ies I learned to count in different bases with Dienes blocks in a similar way which is the standard approach for teaching the bundling concept of the place value system. For binary, the underlying algorithm refers to the so-called Egyptian multiplication, which was already used by Ahmes (ca. 1650 BCE). When multiplying any given number by 1 the number is so decomposed into its binary components. The game below results in correct place value numbers for any base $n > 1$.

To help the child play this, all units (single magnetic cubes) are laid out on an area. The child is then either given the base n or asked to choose one. From then the standard bundling rules apply: recursively count n objects and construct the next Dienes block in order (long, flat or large cube). When less than n objects remain: put these remainder object(s) in the next left table column, starting from the right column. A header row with wooden Dienes blocks may indicate the correct column.

A physical representation of the resulting table can be seen in Figure 1 where wooden Dienes blocks (n=2) are used as header row, resulting magnetic Dienes blocks were put in the next row and the according binary number is written in the third row with wooden flip coins.

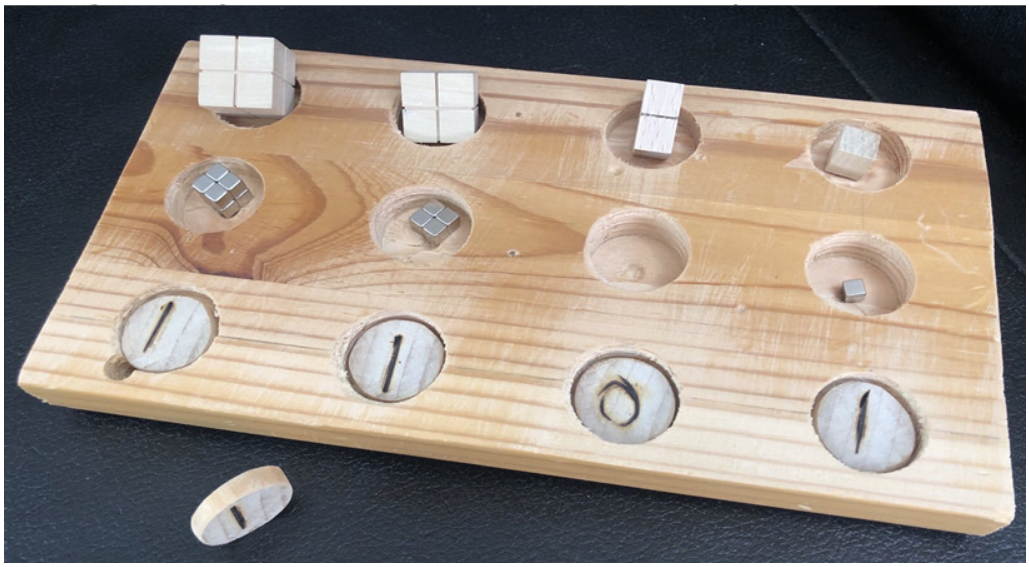

Figure 1: Counting Game – physical representation of the counting table including wooden flip coins

As the proposed age to introduce the game is from 40 months the children may not know how to write numbers. In that case either the flip coins are used or the child is asked to draw a line for one object and a circle for no object remaining. This implies base two is chosen which is recommended to start with.

The approach has been tested so far on a very small sample of three kids, starting at the ages of 3, 5 and 6 respectively. Tests indicate very strong motivational effects as all kids are regularly demanding to play the game again and try hard following the rules as outlined above. Correct numbers are generated with the wooden chips as well as by writing. This holds true for different bases (n being among 2, 3, 4, 5 and 10) indicating successful generalization, reached through almost nonverbal means.

Additional research shall be conducted including to expand and formalize the sample while also investigating the relation of this game to the concept of number conservation (Piaget 1952). Equally of interest is the distinction of kids who are already familiar with base ten and those who aren't.

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