A classical dot pattern-based approach to algebraic expressions in a multicultural classroom

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Introduction

In February 2016, the Otto-Kühne Schule in Bonn, Germany, established an International Preparation Class (IVK, Internationale Vorbereitungsklasse) for 20 foreign pupils from different conflict and war zones all over the world. In this class, they learn the German language as foreign language adequate to their skill level (12 hours per week) and other subjects such as mathematics (5 hours per week). Their educational background is very heterogenous and therefore their mathematic class is usually split into at least three different groups covering topics from multiplication tables to quadratic functions. This project focuses on learning material developed for one group in their first lessons about algebraic expressions and their manipulation. The above-mentioned restrictions and conditions led to the necessity to develop a special approach[1] with few lingual prerequisites and the potential to support the development of mathematical language.

Theoretical background

According to an analysis of German textbooks by Prediger & Krägeloh (2015, p. 91), variables are usually introduced by lingual means. In particular, for the generalising aspect (Arcavi et al., 2016), it is referred to the everyday language. Taking important literature on structure sense resp. structuring (Hoch & Dreyfus, 2004, 2006; Rüede, 2012) into account, the learning material was constructed with a twofold goal: on the one hand the material should be easy accessible (in a linguistic way) in which the students can broaden their notion of variable while on the other hand the material may foster the activity of structuring on a beginner level. For this, dot patterns (or: figurative numbers) were chosen. By a figurative number, we mean a sequence of pictures consisting of dots (Figure 1) and the related number sequence.

Figure 1: The "filling glass" with the sequence 6, 10, 14, …

[1] For more details on the current status of the project, we refer to: http://www.math.uni-bonn.de/people/sauerwei/

Actual setting

The class started with a discussion of the dot pattern in Figure 2. The leading questions were: How many dots are in each picture? Can you continue the pattern? How many dots are in the 4th picture? How many dots are in the 100th picture? How many dots are in arbitrary picture?

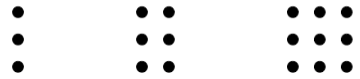

Figure 2: Adding three dots with the sequence 3, 6, 9, …

This very basic introductory example could catch the attention of every pupil. Even pupils with a usually low motivation for mathematics participated actively. All the questions were answered promptly and correctly and the only reasonable formula was found (3x). At this point, we did not introduce the formula (x+x+x) for adding the rows since we did not want to lead the pupils in any direction. From there on, the class worked individually or in smaller groups with the same leading questions on other dot patterns. It was stressed by the teacher that there can be many correct expressions for each pattern, but that each expression requires its own justification. Moreover, it was agreed on that two expressions are only equal if they yield the same result for every number plugged in. Hence, the only chance to verify equality was via the dot patterns and their structure. Thus, the dot patterns became a tool for argumentation.

This project is ongoing and more cycles of implementation in different regular and international classes are in preparation.

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