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Windows on students' algebra: Describing their habits of mind

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This paper illustrates students' algebraic habits of minds through interviews and demonstrates how students have difficulties in algebra. In this study we present data from clinical interviews with sixth grade students, which were analysed using Driscoll's (1999) framework of algebraic habits of mind. All students show different algebraic habits of mind and their difficulties in algebraic concepts constrain their ways of thinking.

Keywords: Algebra, habits of mind.

INTRODUCTION

One major learning goal of mathematics education is to improve students' different ways of thinking. When students spontaneously and are likely to use mathematical ways of thinking, it is reasonable to call them mathematical habits. Several researchers have studied mathematical habits of mind (Lim & Selden, 2009). Mathematical habits of mind are viewed as

students' mathematical thinking in the same way mathematicians do (Cuoco, Goldenberg, & Mark; 1996). Mathematical habits of mind are general approaches and there are also content-specific habits such as algebraic habits of mind. Driscoll (1999) provides a theoretical framework for algebraic habits of mind. He considers algebraic habits of mind as habituated ways of thinking that help students succeed in learning algebra. Further, Driscoll (1999) concentrates on three algebraic habits of mind: (1) doing-undoing, (2) building rules to represent functions, and (3) abstracting from computation. These critical habits of mind help students to use and apply what they know and have learned when they encounter any problem they have not specifically learned. Students who have not developed different habituated ways of thinking struggle particularly with algebra and mathematics in general. This research, being in the initial stage of an ongoing longitudinal study is designed to bring students in algebraic habits of mind in over two years. The purpose of the study is to investigate sixth grade ele-

Categories	Indicators	NUR	ALİ	GÜL	CAN
Doing-Undoing	Working the steps of a procedure backward	✓	✓	✗	✓
	Finding initial conditions from a solution	✓	✗	✗	✓
Building Rules to Represent Functions	Organizing information in useful ways	✓	✗	✓	✓
	Describing change in a process	✓	✓	✓	✓
	Noticing a rule at work and trying it how it works	✗	✗	✓	✓
	Describing the steps of a rule without using specific inputs	✗	✗	✗	✗
	Justifying why a rule works for any number	✗	✗	✗	✗
	Seeking and using connections across different contexts or different representations	✗	✗	✗	✓
Abstracting From Computation	Looking for shortcut in computation	✗	✓	✗	✓
	Thinking about calculations independently of the particular number used	✗	✓	✗	✓
	Recognizing equivalence between expressions	✓	✓	✓	✓
	Expressing generalizations about operations symbolically	✗	✗	✗	✓

Table 1: Each student's algebraic habits of mind

mentary students' acquired algebraic habits of mind after completing their first year of algebra domain. Initial interview results will help us to plan the next steps of this research to support students' algebraic habits of mind.

METHODOLOGY

Participants of this study were four sixth grade middle school students. Data were collected through clinical interviews at the end of the sixth grade. Students were given problems to solve and, after solving each problem, they were asked for detailed descriptions, and to apply different ways to solve problem. The four interviews were fully transcribed and students' responses were put into one of the Driscoll's algebraic habits of mind indicators and categories.

RESULTS AND DISCUSSION

The results indicate that all students exhibited some algebraic habits of minds at the end of the sixth grade (Table 1). However, students' difficulties in conceptualizing algebraic concepts appeared to constrain their ways of thinking.

As shown in Table 1, the indicators of algebraic habits of mind vary across individual students. In the interviews, all students described change in a process and recognized equivalence between expressions. In addition, none of the students described the steps of a rule without using inputs, and justified why a rule works for any number. Thus, students did not seem to exhibit various and different thinking ways. This has implications for teachers and for us. Teachers should benefit from students' thinking in designing their mathematics courses, and use interviews as a tool to further investigate their students' thinking. As a next step, we will further design our mathematics course primarily to gain students how to describe the steps of the rules without using specific input and how to justify why a rule works for any number. Additionally, we will overcome students' difficulties about algebraic concepts and support all indicators of students' algebraic habits of mind.

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