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Middle School Students' Conceptions on Proportional Reasoning

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Abstract
Proportions are an important mathematics concept taught during middle school. In fact, proportional reasoning is "a milestone in student's cognitive development" (Lobato & Ellis, 2010, p. 48) and plays a critical role in developing algebraic thinking and function sense (National Council of Teachers of Mathematics, 2013; National Mathematics Advisory Panel, 2008). However, ratios and proportions are traditionally difficult concepts as Lamon (2007) stated: "the most difficult to teach, the most mathematically complex, the most cognitively challenging" (p. 629).

Keywords
Rational Numbers, Middle School Education, Problem Solving

Disciplines
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Comments
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In this study, students (n = 59) in grades 6-8 in the Midwest of the United States solved a set of eight tasks involving ratios and proportions in an open-ended manner. Contextual tasks and non-contextual tasks were mixed in the assessment set. From initial coding, we constructed the following codes to describe what methods or misconceptions made by the students: additive reasoning (A), cross multiplication (CM), equal amount (E), equivalent ratio/fraction (Erf), and confused about "whole" (W). Then, the students' written responses were coded, using the method of content analysis. Using inter-rater reliability, we have 95% agreement on one task among two authors.

We would like to share the result of one of the tasks, which involves the context of proportional division because the students in all grades struggled the most to solve this task. Approximately 10% of them were able to find a correct answer. Other students made multiple types of errors, such as using additive reasoning instead of multiplicative reasoning (36%), incorrectly applying an algorithm of equivalent ratios (19%) or cross multiplication (5%), and confusing with the whole quantity (16%). This reveals that knowing algorithms does not guarantee students can solve a proportional task as Tjoe (2014) argued. This implies that these students have not developed proportional reasoning although they have procedural knowledge of proportions.

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