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Proportional Reasoning in Middle School

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Abstract
The ability to reason proportionally is a foundational concept for students to master while in middle school, leading to increased understanding and deeper conceptualization of higher level mathematics and science in the later grades (Heller et al., 1989; Johnson, 2015; Lesh, Post, & Behr, 1988; Lobato & Ellis, 2010; Ellis, 2013; Carney et al., 2015). Yet mathematics education lacks research-based teaching strategies on developing proportional reasoning skills in middle school students. This study seeks to determine the influence that specific ratio relationships and models (diagrams) have on student thinking regarding a given proportional reasoning problem and its solution via cognitive interviews with 29 middle school students in Idaho. Results may inform teaching practices on proportional reasoning.

This scholarly poster is available at ScholarWorks: https://scholarworks.boisestate.edu/gss_2018/24
I. Introduction

The Common Core State Standards Initiative in Mathematics (2010) place an increased emphasis on proportional reasoning in middle school (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). However, research has shown that many students struggle in their understanding and use of proportional reasoning. This research study addresses the influence of mathematical models and ratio relationships in students’ ability to reason proportionally as follows:

- How does changing the mathematical model influence student strategies and student conceptions?
- How does shifting the numerical quantities of the given ratio change both student strategies and student conceptions?
- In what ways does the given mathematical model or ratio relationship press students to specifically solve via composed unit or multiplicative comparison?

According to National Council of Teachers of Mathematics (NCTM), a foundational component of proportional reasoning is one’s ability to create a ratio by “attending to two quantities simultaneously” (Ellis, 2013, p. 1), either by reasoning is one’s ability to create a ratio by “attending to two quantities simultaneously” (Ellis, 2013, p. 1), either by

II. Methods

In Winter 2018, I conducted cognitive interviews with 29 middle school students in the state of Idaho. Students were asked the same six questions while being provided with one of four problem sets. The problem sets maintained a constant context (cookies and cost) but differed in the given mathematical model (tape diagram; bar model) and/or ratio relationship (6 cookies to $3; 5 cookies for $2) as the following graphic displays. I analyzed and coded student responses based upon their understanding of the context and statements of the relationship between the two given variables.

III. Results

Mathematical Models

- The bar model aided more students in solving via multiplicative comparison than did the tape diagram.
- The tape diagram was more influential in aiding students to see dollar and cookie unit rates.

Ratio Relationships

- The 6 cookies : $3 ratio relationship influenced students to use the composed unit strategy and identify the dollar unit rate and cookie unit rate.
- The 5 cookies : $2 ratio relationship was more challenging as students struggled to identify a relationship between the variables. Students also found it easier to scale up to a larger ratio than scale down to the unit rates.

IV. Conclusions

While I gained valuable insight into the influence of bar models, tape diagrams, and ratio relationships in these tasks, more research is needed to confirm these findings.

Further research with larger sample size will enhance the validity and generalizability of these results.

I would also like to study the implications of the order sequence of my interview questions as well as the effects on a different population of students.

References

