

Students' Approaches to Solving Proportional Problems



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Introduction

Proportional reasoning is the foundation for algebra and further mathematics. It is a complex concept for middle and high school students to comprehend.¹ Our research focused on determining how students attempt to understand proportional reasoning. We created a series of proportional word problems and administered it to students in grades five through nine. Our analysis of the students' work revealed a variety of strategies.

What Is Proportional Reasoning?

Proportional reasoning is the ability to evaluate the direct or indirect relationship between two quantities.² Our research focused on direct proportion, which means that as one quantity increases, the other increases as well.

Problem Solving Strategies

- ❖ Proportional Reasoning
 - Students set up the proportion algorithm and use the cross-product method.
- ❖ Multiplication 1 – Equivalent Fractions
 - Students multiply the numerator and denominator of the initial fraction by the same value.
- ❖ Multiplication 2
 - Students divide to determine the multiplier, which they then use to find the unknown quantity.
- ❖ Ratio Table
 - Students set up a table of values such that each new set of numbers is a multiple of the original ratio.
- ❖ Visual Representation
 - Students draw a picture or diagram that indicates the relationship between the two quantities.
- ❖ Additive
 - Students add or subtract a number to or from each part of the ratio, rather than multiplying each part of the ratio by a constant.

Student Work

Our examples come from ninth grade work. Although these students have used the cross-product, they still used multiple ways to solve the problem. Students used five out of the six indicated strategies to answer the following problem about dodgeball:

Patty lost 3 games out of every 8 games she played. She lost 12 games during the season. How many games did she play?

Proportional Reasoning

The student set up the proportion algorithm by comparing 3 losses out of every 8 games to 12

total losses out of an unknown amount of total games. He or she then used the cross-product method to solve for x.

Multiplication 1 – Equivalent Fractions

The student added 3 losses 4 times to get 12 total losses. He or she then added 8 games the same number of times to get 32 total games. The student then recognized that this would be the same as multiplying both 3 games lost and every 8 games played by 4 to get the equivalent fraction of 12 losses out of 32 total games.

Multiplication 2

The student divided 12 total losses by 3 losses to find a multiplier of 4. He or she multiplied 8 games played by 4 to find the total number of games played.

Visual Representation

The student drew groups of 8 circles to represent games played and filled in 3 circles per group to represent losses. He or she continued in this manner until he or she obtained 12 losses. The student then counted the total number of circles to find the total number of games played.

Additive

The student repeatedly added the ratio 3 losses out of every 8 games until he or she obtained 12 losses and the corresponding 32 games played.

Conclusion

Our research shows that students use multiple strategies to solve proportional problems. While all the strategies are related to each other, and all are capable of attaining the same result, some strategies require more abstract thinking. The proportional reasoning strategy is a more formal strategy that is the commonly desired result, but it is important for students to understand the relationship that it represents.

Several factors may influence how a student approaches a proportional problem:

- ❖ If the numbers are too simple, students may revert to less abstract strategies.
- ❖ The level of experience a student has with proportional reasoning.
- ❖ The context of the problem; whether a student is familiar with terminology and the scenario.
- ❖ Which of the values is unknown is also a factor.

Future research on students' understanding of proportional reasoning could focus on any of the above factors and the extent to which these factors affect students' approaches to and understanding of proportionality.

References

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- ² Lamon, S.J. (1999). *Teaching fractions and ratios for understanding: Essential content knowledge and instructional strategies for teachers* (p. 8). Mahwah, NJ: Lawrence Erlbaum Associates, Publishers.

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