

THE DEVELOPMENT OF RATIO CONCEPTS IN EARLY ELEMENTARY SCHOOL THROUGH PROBLEM SOLVING

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The concepts of ratio and proportion are considered to be very difficult in elementary school and throughout high school. In fact, Piaget (1966) viewed proportional thinking as a key ability developed in the formal operational stage. Many adults, including student teachers and teachers and people in different occupations (nursing, fishermen, carpenters, etc.), do not understand these concepts well or used localized strategies to solve problems (Fisher, 1988; Keret, 1999 (PME); Klemer & Peled, 1998 (PME); Tourniaire & Pulos, 1985).

Although some ratio problems are very complex and demand abstract thinking, it is important to help children construct ratio concepts while they are young. At this age the children can develop intuitive understanding of the ratio concepts and they can have opportunities to model the problems with concrete objects or drawings. Hopefully, when these children grow up, they will have a sound conceptual base to build on.

This study documents solution strategies for ratio and proportion problems in young children (grades one to three). This data is part of a larger project of learning mathematics through problem solving in a constructivist way by a branch of Cognitively Guided Instruction (CGI) (Carpenter & Fennema, 1996). In this project there is an emphasis on children developing their own unique methods of solution. The children reflect on their solutions and ideas and communicate them to others. The teachers learn about the children's thinking and build the instruction on it.

The children solved the ratio problems by using manipulatives and drawings and by seeing mathematical relationships. Almost all the children could solve the problems correctly, including sophisticated strategies (some needed direction from the teacher such as a request for drawings). Examples of problems: "For the price of 2 thick notebooks you can buy 5 thin ones. How many thin notebooks can you buy for the price of 20 thick ones?" "In a class there are 30 children. For every 3 boys there are 2 girls. How many boys and girls are in the class?" Other problems scale the amounts of ingredients in a recipe. Example: to make 500 grams of beans we used half a cup oil, a quarter teaspoon of pepper, 4 tomatoes etc. How much would we use to make 750 grams? An example of a third grader solution to the last problem: 250 grams goes twice into 500 grams and 3 times into 750 grams. So you divide all the amounts by 2 and multiply by 3. So half a cup of oil corresponds to the 500 grams. 250 grams corresponds to $\frac{1}{4}$ cup. 750 grams corresponds to 3 times $\frac{1}{4}$ and this is $\frac{3}{4}$ cup oil.