Using multiplication and division contexts to enhance young children's part-whole thinking in mathematics

Associate Professors Brenda Bicknell and Jenny Young-Loveridge, with Jo Lelieveld, Lauren Hodge, John Brooker, Jackie Simpson and Angela Vandy (January 2013 to December 2014)

Introduction

This project explored how multiplication and division contexts could be used to help young children develop a greater appreciation of the properties of numbers. By exposing children to problems not traditionally used with this age group, the study aimed to contribute to improving student outcomes in mathematics for a diverse range of learners. These problems included contexts familiar to the children where explicit equal-sized groups (e.g., two socks in a pair, five fingers on a glove, ten eggs in a carton) were used. The children worked together as a class to talk about, model, and find solutions for problems using multiple representations. In the process of participating and contributing to the classroom discourse, they were encouraged to communicate their ideas mathematically using language, symbols, and texts. The children also worked independently on problems where the numbers were differentiated to provide appropriate challenge and to allow more able students to work with larger quantities (e.g., 3-digits).

Why is this research important?

Research evidence from a large cohort of New Zealand students shows that at most year levels, insufficient numbers of students meet (or exceed) the expectations reflected in the Curriculum and National Standards. Junior class teachers traditionally focus on addition and subtraction without recognising the value of multiplication and division contexts for enhancing part-whole thinking. Part-whole thinking is fundamentally important for the development of an understanding of many key mathematical ideas such as place value, multiplication, division, algebra, fractions, ratios, and proportions. This project explored the use of appropriate word problems that focused on equal-sized groups within the whole quantity.

The project

This project consisted of several components:

- assessment of individual students using a diagnostic task-based interview;
- the development of appropriate word problems and selection of supporting materials;
- extending learning and teaching experiences;
- recording using multiple representations in a class modelling book and children's own project books; and
- reflecting and evaluating experiences for all participants.

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The findings

In the first year of the study, children were from Year 1 and Year 2, and in the second year of the study, from Years 1 to 3. In both years of the study, children made substantial progress in problem-solving strategies for addition and subtraction, multiplication, and division, as shown by effect sizes for improvements of between 0.77 and 2.56 (An effect size is a standardized measure of difference. According to Hattie (2009)*, an effect size greater than 0.60 signifies excellent progress for one year of schooling). Children's knowledge of known facts also improved noticeably (effect sizes ranged from 0.78 to 1.50), as did their skip counting in multiples of two, five, and ten (effect sizes of 1.03 and 1.32). An unexpected finding was the improvement in performance on tasks designed to measure knowledge about groups of ten (an early stage of place-value understanding). In both years, the effect sizes were more than one standard deviation (1.52 and 1.34 in 2013 and 2014, respectively). Knowledge about groups of ten included knowing how to add a multiple of ten to another quantity (20+7, 10+8, 5+10, 15+10, 25+10), and knowing multiplication and division facts with ten (e.g., 2x10, 3x10, 4x10, 80÷10). The interview also included tasks designed to assess place-value understanding (e.g., the number of $10 notes needed to buy an $80 item, linking the '2' in '24' to 2 tens or 20, solving a quotitive division problem involving groups of ten with remainder, such as 23÷10). Subitizing (two 5-dice, a ten-frame, and ten-frames combined with single dots) was also an area of substantial improvement in 2014 (effect size of 1.17).

*Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. London, England: Routledge

Contact details

Associate Professor Brenda Bicknell
Te Hononga School of Curriculum & Pedagogy
Faculty of Education,
The University of Waikato
Email: bicknell@waikato.ac.nz
Phone: 07 838 4466 xtn 6971
Associate Professor Jenny Young-Loveridge
Te Hononga School of Curriculum & Pedagogy
Faculty of Education, The University of Waikato
Email: educ2233@waikato.ac.nz
Phone: 07 838 4466 xtn 4353