Telling and illustrating additive relations stories

A classroom-based design experiment on young children's use of narrative in mathematics

Nicky Roberts

Thesis submitted in fulfilment of the requirement for Doctor of Philosophy, University of Witwatersrand.

Supervisor: Prof Hamsa Venkat

DECLARATION

I hereby declare this PhD thesis, and the work presented in it, to by my own and to have been generated by me as result of my own original research. It has not been submitted for degree purposes to any other university.

_____

N. Roberts

6 May 2016

Abstract

In South Africa, difficulties with learners solving word problems has been a recurrent problem identified through national standardised assessments extending from Foundation Phase into the Senior Phase. As is evident globally, particular difficulties have been identified with young children solving 'compare-type problems' where the numbers of objects in two disjoined sets are compared. This design experiment provides empirical data of young South African learners trying to make sense of compare-type problems. The task design from this design experiment suggested that engaging learners in narrative processes where they are expected to model the problem situations and then retell and vary the word problems, to become fluent in using the sematic schemata may assist them to become more experienced and better able to make sense of compare-type problems. This finding contradicts the advice offered in official South African government documentation.

The study was a three-cycle classroom-based design experiment which took place over 10 consecutive school days with Foundation Phase learners in a full service township school where the majority of learners were English Language Learners (ELLs), learning mathematics in English when their home language has not English. This study set out to research a 'narrative teaching approach' for a specific mathematics topic: additive relation word problems. At the heart of the study therefore, was a question relating to the efficacy of a teaching strategy: To what extent do young children's example space of additive relations expand to include compare type word problems?

This design experiment reveals that when adequately supported with careful task design and effort in monitoring and responding to learner activity, Grade 2 ELL children in a township school *can* improve their additive relations problem solving, in a relatively short time frame. The majority of the learners in this design experiment were able to solve compare-type problems at the end of the 10-day intervention. These learners were also able to produce evidence of movements towards more structured representations, and towards better learner explanation and problem posing using storytelling.

The design experiment intervention showed promise in expanding young children's example space for additive relations word problems. In both cycles the mean results improved from pre-test to post-test. The gains evident immediately after the intervention were retained in a delayed post-test administered for the third cycle which showed further improvements in the mean with a reduced standard deviation. The effect sizes of the shifts in means from pre-test to post-test was 0.7 (medium) in both cycles, while the effect size of shifts in the mean from pre-test to delayed post-test was 1.3 (large). T-tests established that these shifts in means were statistically significant. The core group showed the greatest learning gains, suggesting that the intervention was most successful in 'raising the middle' of the class.

Particular patterns of children's reasoning about additive relations word problems are documented from the South African ELL children in this design experiment. For example many ELLs in this design experiment initially responded to compare word problems like *'Mahlodi has 12 sweets. Moeketsi has 8 sweets. How many more sweets does Mahlodi have than Moeketsi?*' with: *'Mahlodi has 12 sweets'*. New actions and contrasts relating to additive relations are brought into focus. For example the empirical results indicated that inserting attention to 1:1 matching actions was found to be useful to helping learners to deal with static compare situations.

This study has helped to extend the theoretical foundations of what is meant by a 'narrative approach' as the theoretical features of the narrative approach are now situated within a broader theoretical framework of orienting theories, domain specific instructional theories, and related frameworks for action. The findings of this design experiment have been promising in the local context of the focal school. Should the intervention task design be found to yield similar results in other South African Foundation Phase contexts, when implemented by teachers other than the researcher, then it may be appropriate to use the research findings to improve the guidance provided to Foundation phase teachers (in curriculum documentation and through professional development offerings).