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Using design-based research to develop a professional development intervention for grade 9 South African teachers' mathematical problem-solving pedagogy

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Abstract

This study, which is comprised of two phases, employed a mixed methods design-based research (DBR) methodological approach within a pragmatist research paradigm to develop a professional development (PD) intervention that can be used to support grade 9 mathematics teachers in the teaching of problem-solving. This study is located in the broad area of designing and developing interventions that can improve the teaching and learning of mathematics in South Africa. The first phase of this study involved a review of relevant literature, context analysis and a baseline investigation with 31 grade 9 mathematics teachers at 20 public secondary schools within a certain district in Gauteng, South Africa. During the baseline investigation, participant teachers completed an open-ended questionnaire. The purpose of the baseline study was to investigate participant teachers' views, teaching strategies and the support they required in their teaching of mathematical problem-solving. The baseline investigation revealed that teachers in this district had a partial understanding of the teaching of mathematical problem-solving and were teaching problem-solving using 'traditional' approaches that did not seem to support problem-solving processes in learners. I reached a conclusion that there was a need to develop interventions to support the grade 9 teachers in this particular context in their teaching of mathematical problem-solving.

Based on the findings from the baseline study, I developed a PD intervention for grade 9 teachers' mathematical problem-solving pedagogy in phase two of this study through two design-enactment-evaluation-redesign cycles. These cycles took place in two successive years with a total of four grade 9 mathematics teachers and 211 learners (cycle 1: two female teachers and 115 grade 9 learners; cycle 2: one female and one male teacher and 96 grade 9 learners). Each cycle was followed by data analysis and evaluation and refinement of the prototype.

I collected data through mixed methods data collection procedures. In this regard, I analysed qualitative data through inductive data analysis techniques with constant comparisons. I analysed quantitative data using the statistical package SPSS.

Although limited to a particular context, the main goal of this study was to develop a PD intervention that can be modified and used by the South African Department of Basic Education. Furthermore, this study aimed to generate design principles that can be used by other researchers, mathematics education practitioners and teachers developing PD interventions for mathematical problem-solving pedagogy. As a result, the design principles that emerged from this study include design principles for PD in general and design principles specifically for PD for mathematical problem-solving pedagogy. Design principles for PD, in general, are that: facilitators of PD must create a positive relationship with participant teachers before implementing the intervention; participant teachers should be used as a resource and must actively participate in the implementation of a PD intervention; teachers should be physically supported in their classrooms when they implement the new ideas; respecting participants is important in an African context when implementing the PD intervention; peer observation for teaching can be used as a PD strategy to support teachers' pedagogy; and a PD intervention should be responsive to the multi-lingual needs of a particular context. Design principles for PD for teachers' mathematical problem-solving pedagogy mainly comprise of the following: a baseline investigation must be conducted to establish teachers' views and practices on the teaching of mathematical problem-solving before implementing the PD intervention; PD activities should be built from teachers' experiences and their current mathematical problem-solving pedagogy; PD should be organised around collaborative problem-solving; and task-based interviews may be used to observe learners' mathematical problem-solving behaviour in detail to evaluate the impact of teachers' pedagogy on learners' problem-solving processes.