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Learner errors in algebraic equations: seeking sense in the chaos

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Abstract

The fundamental aim of this mixed-methods research was to investigate learner errors in solving linear equations, and the possible relationships between errors. Solving linear equations was used as the context in which to compare errors. This aim was chosen because of the persistent poor standard of mathematics attainment in the majority of schools in South Africa. Conducting an error analysis provides one with the tools that will then allow for the diagnosis and remediation of learning deficits. To solve a linear equation a learner needs to be competent in other mathematical topics such as equality, integers and adding like terms.

Quantitative research methods were used on a large sample of Grade 9 and 10 learners (n =2135) as well as on a subset consisting of 150 Grade 9 learners and 150 Grade 10 learners. T-tests and correlations were used to analyse pre- and post-tests results. Taking a social constructivist (Vygotsky, 1978) approach to learning and learner errors, the subset of data was also analysed qualitatively. Both typological and inductive data analysis was employed in the topics of equality, integers, expressions and equations. Having found common errors, a change in errors was explored between the pre- and post-tests, and possible relationships between errors were investigated. In general learners performed poorly in the topics mentioned above. However, Grade 10 learners made more gains than Grade 9s, suggesting that the extra exposure to mathematical content was necessary to improve test scores and reduce errors.

I term this theoretical idea of more exposure and time needed for internalisation to take place, 'synk time'. I argue that learners need time for content to settle in their minds and built this idea from three theoretical constructs: Vygotsky's (1978) notion of *internalisation*; Tomasello's (2003) notions of *intention reading* and *pattern finding*, and Gopnik and Meltzoff's (1997) notion of *The Theory Theory*. The integration of these constructs and the notion of 'synk time' is a theoretical contribution of this thesis.

The qualitative analysis revealed a surprising finding: that the majority of Grade 9 learners did not use inverses to solve equations but rather used arithmetic. In Grade 10, more learners treated the equal sign as a relational symbol. In the related topics, learners who made integer errors and errors with letters did so more in the individual topics rather than when solving equations.

The two major contributions of the thesis are theoretical and methodological. Theoretical in that I integrate three theoretical constructs to explain why Grade 10 learners make more gains than Grade 9 learners. The methodological contribution is that I show how a randomly selected sample of 150 learners can be generalised to a larger group.

Recommendations for future research point towards an investigation into the amount of time given for backlogs in mathematics as well as what revision is covered in the curriculum. Other recommendations include conducting this research with the lens of determining whether there is a hierarchy of errors. This would enable us to see improvement amidst poor performance.