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First-year university students' algebraic thinking and its relationship to geometric conceptual understanding

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ABSTRACT

This study investigated how first-year university students at Universidade Pedagógica (Pedagogical University) in Maputo-Mozambique brought their knowledge and thinking of algebra in understanding and working with geometry. The study explored how these students connected and used algebraic and geometric concepts and investigated whether this connection promoted students' conceptual understanding and problem solving performance in geometry.

The main body of the research was done in three phases, which were analysed separately. The three phases were the Pilot Study, the Main Study – Euclidean Geometry Course, and the Main Study – Analytic Geometry Course. Transcripts from the interviews with the target students, and the artefacts collected from the students (Pilot test, Diagnostic test, and written responses to the Elaboration and Concept Mapping Task) constituted the bulk of the data for this study. The data collection was carried out during two successive semesters.

The constant comparative method and the grounded theory were used in the analysis of the data. A model was adapted from the literature (Charbonneau, 1996; Stillwell, 1998; and Duval, 1998) to explore how algebraic thinking might be an aid to geometrical understanding . It shows that the cognitive processes (symbolization, relations, and abstraction), which underlie algebraic thinking, are interconnected. These cognitive processes might jointly be used to aid any of the cognitive processes which constitute geometrical understanding (visualization processes, construction processes, and reasoning), either separately or jointly. Prawat's (1989) framework on transfer and learning appeared to be relevant to analyse the data collected in the study: (Knowledge connectedness and communication, general and specific strategy, and mastery and performance disposition).

The results showed that in Analytic Geometry the students needed intuition (synthetic strategies) to inform their reasoning (analytic strategies). In the contrary, in Euclidean

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Geometry they needed reasoning (analytic strategies) to inform their intuition (synthetic strategies). However, I observed that this balance still needed to take place in my target students' mind. In other words, in Analytic Geometry, my students needed geometric thinking to aid their algebraic thinking and in Euclidean Geometry, they needed algebraic thinking to aid their geometric thinking. This mutuality in geometry seems to underpin what Schoenfeld (1986) found that the interaction of deductive (as a means of discovery) and empirical (as a means of development of intuition) approaches to geometry leads students to reap the benefits of their knowledge.

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