Chapter 17
Best Practices and Case Studies of Teaching and Learning Mathematics in Higher Education

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ABSTRACT

Presently, a major desire of many African nations is to be technologically developed. In Southern Africa there tends to be an acute shortage of skilled manpower in the field of science, engineering, and technology. The interrelationship between Mathematics and development of humans to advance the cause of humans is a fundamental importance of Mathematics to humans. In this chapter, the author draws on the many empirical studies which address quality in teaching and learning. The focus of the chapter is to summarize the many research studies in Southern Africa which address the teaching and learning of Mathematics in Higher Education. The author shall confine the studies to those which adopt APOS (Actions-Process-Object-Schema) as a theoretical analysis. So far no research seems to have collated such African studies in a cohesive manner and this chapter intends to do that.

INTRODUCTION

Presently, a major desire of many African nations is to be technologically developed. In Southern Africa there tends to be an acute shortage of skilled manpower in the field of science, engineering and technology. The interrelationship between Mathematics and development of humans to advance the cause of humans is a fundamental importance of Mathematics to humans. In this chapter the author draws on the many empirical studies which address quality in teaching and learning. The focus of the chapter is to summarize the many research studies in Southern Africa which address the teaching and learning

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of Mathematics in Higher Education. The author shall confine the studies to those which adopt APOS (Actions-Process-Object-Schema) as a theoretical analysis. No Textbook has collated such African studies in a cohesive manner and this chapter will intend to do precisely that.

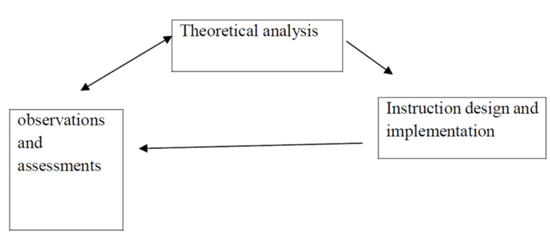
The Research Framework

APOS studies implement a research framework postulated by Asiala, Brown, DeVries, Dubinsky, Mathews, & Thomas (1996). The theoretical analysis (see Figure 1) produces assertions about mental constructions that can be made in order to learn a particular mathematical topic, instruction tries to create situations which can foster making these constructions, observation and assessment tries to determine if the constructions appear have been made and the extent to which the student actually learned (Asiala et al., 1996). For this chapter the author will consider theoretical analysis with a focus on mental constructions. Under theoretical analysis APOS theory of Dubinsky will be useful by which he describes the cognitive structures used by students to construct knowledge through action, process, object and schema. APOS theory is a theoretical framework for the process of learning Mathematics that pertains specifically to learning more advanced mathematical concepts (Weyer, 2010).

It is a theory that is premised on the hypothesis that mathematical knowledge consists of an individual's tendency to deal with perceived mathematical problem situations by constructing mental *actions*, *processes*, and *objects* and organizing them in *schemas* to make sense of the situations and solve the problems (Dubinsky, McDonald, & Weber, 2007). According to Cooley, Loch, Martin, Meagher, & Vidakovic (2006)' APOS allows for the development of ways of thinking about how abstract Mathematics can be assimilated and learned. Figure 1 shows the research framework for research and curriculum development. It is with this research framework that the theoretical framework adopted from Jojo, Brijlall, & Maharaj (2013) fits theoretical analysis.

For the theoretical analysis stage of the research framework, the studies under discussion in this chapter, use APOS theory. For the Instruction design and implementation stage all these studies derive their formulation from the ACE cycle (Asiala et al. (1996). The A stands for activities, the C for classroom discussion and E for exercises done. This ACE teaching cycle is a pedagogical approach, based on APOS theory. It is a repeatable cycle and the activities designed are supposed to foster the students' development of the APO mental structures. This development depends on the opportunities for learning both in and outside the classroom. By engaging in these mathematical opportunities, students are guided by the teacher/lecturer to reflect on the activities and their relations to the mathematical concepts being taught. The lecturers then facilitate discussion in relation to the results produced by the students. This discussion involves the student explaining herself/himself within the classroom on an individual

Figure 1. The research framework
Source: Asiala et al., 1996



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