Using *GeoGebra* as a dynamic mathematics software tool for mathematical modelling in school mathematics

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Abstract

This PhD research study aims to investigate how selected secondary mathematics teachers can use dynamic mathematics software such as *GeoGebra* as a modelling tool when teaching mathematical modelling. The proposed study will be located within the Otjozondjupa Mathematical Modelling Group (OMMG), a mathematics modelling group established in the Otjozondjupa region, Namibia. This intervention study will specifically analyse the role of *GeoGebra* in mathematical modelling processes and how it can enhance these processes.

Introduction

Mathematics in the Namibian curriculum expected to develop learners' abilities to analyse problems logically, recognise when and how a situation may be represented mathematically, identify and interpret relevant factors and, where necessary, select an appropriate mathematical method to solve a real-world problem ([MoEAC, 2016). One way to fulfil these expectations is by engaging learners in mathematical modelling. Historically, mathematical modelling involved paper-and-pen sketching and designing. There has however been a shift in using these tools to sophisticated computer devices and software (Greefrath, 2011). The mathematics classroom is also benefitting from this shift. There are many technological tools available for mathematical modelling nowadays (Viseu & Leite, 2019) – such as *GeoGebra*.

This study is looking at how best practicing mathematics teachers can be prepared and helped to use computer technology such as *GeoGebra* as a helpful mathematical modelling tool. The study ask the questions:

- What are the selected mathematics teachers' perspectives, experiences and pedagogical insights on the use of technology and mathematical modelling in mathematics classroom before the modelling intervention?
- As a result of participating in the modelling intervention:
  - What TPACK do the selected teachers employ when they adopt a modelling approach in their teaching which incorporate *GeoGebra*?
  - To what extent is the selected teachers modelling teaching practice aligned to the modelling cycle?
  - What are the participating teachers' perceptions and experiences of employing a mathematical modelling approach using *GeoGebra* as a modelling tool?

Theoretical Framework

Realistic Mathematics Education (RME) theory

RME is a mathematics teaching and learning theory that is based on Hans Freudenthal's interpretation of mathematics as a human activity. Freudenthal (1973) proposed that mathematics activities should mostly consist of organising or mathematising subject matter taken from reality. RME emphasis that mathematics should be used as a tool to help learners to solve complex real-life problems (Gravemeijer, 1997). The theory will be used to guide the design of the mathematical modelling tasks.

Technological Pedagogical Content Knowledge (TPACK) theory

TPACK is a framework developed to understand and describe the kinds of knowledge needed by a teacher for effective pedagogical practice in a technology-enhanced teaching and learning environment (Mishra & Koehler, 2008). TPACK tries to describe how teachers' understanding of educational technologies and pedagogical content knowledge interact with one another to produce effective teaching with technology (Koehler & Mishra, 2009). The theory will be used as an analytical framework to understand and describe the kinds of knowledge demonstrated by the teacher for the effective use of GeoGebra.

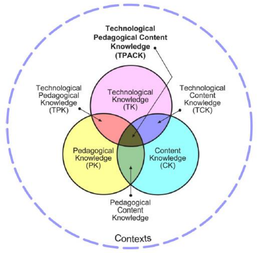

Fig. 1: Illustration of the TPACK framework

The modelling cycle

The modelling cycle is a framework developed by Blum and Leiß (2007) to illustrate the main components of a mathematical modelling teaching approach. Due to the increase use of technology in mathematics classroom, the modelling circle was modified to include the integration of technology. The modelling cycle will be used in this study to understand how the use of *GeoGebra* can be integrated into the modelling process. The modelling cycle adapted in this study is that of Blum and Leiß (2007), as modified by Greefrath et al. (2018)

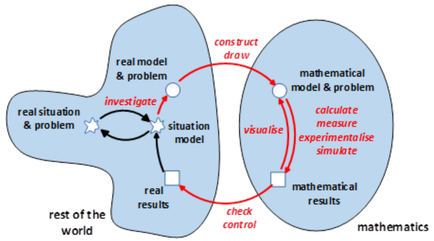

Fig. 2: The modelling cycle

Methodology

In this study, we will analyse how selected teachers will use *GeoGebra* to solve mathematical modelling tasks with Grade 10 learners. A total of about 10 tasks will be use. One of the tasks is given below:

Your school is planning to build a boundary wall. 5 bricks are needed to complete a length of 1-meter and 10 bricks are needed to complete a height of 1-meter. The height of the wall should be about the height of the man in the picture below. You are tasked to find out how many bricks are needed to complete the project. Use a map of your school from Google Map to help you.

We will work with four Grade 10 mathematics teachers from schools in the remote rural area of the Otjozondjupa region, Namibia. All the teachers have no mathematical modelling and *GeoGebra* experience.

Data will be collected through lesson observations, and interviews. During the observation, our focus will be on how the teachers used *GeoGebra* during the lesson presentations. More specifically, we will look at how *GeoGebra* is used to facilitate the modelling process.

The interview will give the teachers an opportunity to express their views about the use of *GeoGebra* as a modelling tool from their own point of view. This will help me to understand and evaluate the participating teachers' perceptions and experiences of using *GeoGebra* as a mathematical modelling tool.

Data was collected from the lesson observations will be analysed using the principles of TPACK constructs and the modelling cycle. Firstly, the analysis of the lessons will focus on identifying evidence of the TPACK constructs' principles. Secondly, the analysis will focus on identifying the modelling process involved with particular reference to how *GeoGebra* was used in the modelling cycle. Data gathered from interviews will be transcribed and analysed by codifying and coding the transcription according to emerging patterns in participants responses.

Concluding remarks

The study presented in this poster is a PhD project in the early stages. In the poster, we presented the outline and the methodology that we intend to use. The study has the potential to benefit Namibian mathematics education by informing teacher practice, subject advisors, curriculum developers, textbook authors and researchers' foci in terms of the applicability and importance of mathematical modelling and technology in school mathematics. The study will also contribute to literature on mathematical modelling with technological tools, and to the understanding of using RME and TPACK as theoretical foundations to mathematical modelling using and supported by information computer technology.

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