
A case study of a university teacher of Calculus 1

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This case study of a university teacher of calculus1, based on data from a questionnaire, semi-structured interview, and observation, illustrates how the teacher used their knowledge of calculus teaching to sequence the building blocks of mathematical theories (BBMT) of the concepts of calculus.

Keywords: teachers' practices, university level, teaching calculus.

INTRODUCTION

Calculus is important at the university level because understanding calculus is an essential step in understanding how the world works. It is a foundation on which other skills can be built and is often a requirement or prerequisite for STEM programmes. Nevertheless, it is a challenging area regardless of which educational institution is offering the instruction (Petropoulou et al, 2016). As such, while there is much research on calculus learning and teaching, Rasmussen et al (2014) identify teacher knowledge as an under-developed topic. In this study our research questions are; how does a calculus teacher demonstrate their pedagogical content knowledge (PCK), to achieve their aims, to develop instructional strategies (ISs), and to assess students' understanding? Here we present elements of a single case study.

RESEARCH ON PCK OF UNIVERSITY TEACHERS

Numerous studies, from Shulman (1987) to Khakbaz (2015), have indicated that teachers require different types of knowledge in the classroom. PCK was proposed by Shulman (1987) as an essential component of teacher knowledge, defined as a "special amalgam of content and pedagogy that is ... understanding" (p.8). Later work by, for example, Khakbaz (2015), confirms that it is necessary to go beyond the subject (e.g. Calculus) and examine how the teacher interprets the subject matter (e.g. the interpretation of calculus) and how this is linked to their role in facilitating learning in the classroom. Research on PCK of university teachers remains limited.

THEORICAL FRAMEWORK AND METHODOLOGY

For the purpose of this study, we adopted Lessing's (2016) PCK framework. Based on this, we take PCK as a combination of knowledge of purposes of teaching calculus, of the building blocks of mathematical theories (BBMT) and of ISs, while taking into account knowledge of learners' conceptions and difficulties.

A mixed methods multiple case study design was adopted for this research. Qualitative data was gathered by semi-structured interview and observation of eight taught sessions of the module from 15 April to 15 July 2017 to explore the ways in

which calculus teachers implemented their PCK in the classroom setting. Quantitative data was gathered using a questionnaire (multiple choice) on their knowledge of ISs, learners' conceptions in teaching and learning calculus, and learning difficulties. The qualitative data was analysed by coding and categorising according to the theme in order to identify the ways that the participating teachers demonstrated their PCK during their calculus teaching.

THE CASE OF TEACHER JOHN

John is a mid-career mathematician with four years of experience of teaching calculus¹ at a university. The calculus teaching strategies employed by John were a pattern of topic-specific ISs based on using the BBMT in teaching calculus. From our data, it was clear that John approached each calculus topic through the BBMT using axioms, definitions, theorems and proof. Therefore, the lecture structure chosen by John often aligned with the mathematical concept used in the topic. Here, John often started the lecture with a definition, then theorem, and then sometimes the proof and then examples illustrated with graphs. On one occasion, John asked the students to read a proof. In an interview, John explained that, in the lectures, students are sometimes asked to read a proof because John wants to understand the students' conceptions, and misconceptions, of proofs. On one occasion, in a part of the topic 'continuous functions on an interval', John gave some examples and asked students to give a definition. At other times, John used ISs such as diagnostic techniques, (through class discussion, etc.), reviewing previous lessons as a way to introduce subsequent lessons, and using various mathematical representations.

CONCLUSION

The analysis of John illustrates how knowledge of calculus teaching (i.e. calculus PCK) was used in sequencing the BBMT of the concepts of calculus. The next stage of the research is documenting other cases as part of the multiple case study.

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