IMPACT OF MATHEMATICS FOR TEACHING THROUGH CONCEPT STUDY ON PRIMARY SCHOOL PRE SERVICE TEACHERS' PROFESSIONAL KNOWLEDGE

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This article describes an investigation into pre service teachers' mathematics for teaching in primary school teacher education in Tanzania. The study focuses on concept study as an approach to study mathematics for teaching for pre service teachers. Its analytic frame is built on Davis and Renert notion of realizations, landscape, entailments, and blends. The study involved 10 first year pre service teachers. The study reveals primary school pre-service teachers' deep understanding of mathematics concepts and mathematics in general, and mathematics for teaching could be built through concept study. The article offers theoretical background of mathematics for teaching and practical explanations for the results and to why this might be so.

Key words: Concept study, Pre-service primary school teacher education; Teacher knowledge, and Mathematics for Teaching.

Introduction

Mathematics education in Tanzania is a concern to the government of Tanzania, with dismal failure rates. The average percentage pass (Grade A-D) in Certificate of Secondary Education Examination (CSEE) for five consecutive years from 2008 to 2012 was 24.33, 17.78, 16.09, 14.55, and 12.14 respectively. Candidates who enter teacher education may have passed Form IV but that pass may include a fail in mathematics. Primary teacher education in Tanzania is relatively traditional, in the sense that the primary pre service teachers are recruited from CSEE, and the teaching strategies in the college do not give room for the teacher candidates to build on their own understandings of mathematics. There is a need to explore suitable teaching strategies to build on the mathematics of teacher candidates so that it is much more suited to teaching than currently. In this research I ask, in what ways does developing mathematics for teaching through concept study contribute to the professional knowledge, skills and attitudes of pre service teachers?

The complexities of mathematics teachers' disciplinary knowledge needed for the effective teaching of mathematics is a challenging problem and it has put a significant pressure on researchers, teacher educators, and practitioners across the world to imagine and develop curriculum and pedagogy for the teacher education classroom. The research has been focusing on kinds of mathematical knowledge, pre-service and in-service teachers need to know and know how to teach mathematics effectively curtailed as "Mathematics for Teaching" (Ball & Bass, 2003; Ball, Hill & Bass, 2005; Davis & Simmt, 2006; Adler & Davis, 2006; Ball et al., 2008; Davis & Renert, 2014). David and Renert (2014) defined mathematics for teaching as "the mathematics knowledge that enables a teacher to structure leaning situations, interpret students' action mindfully and respond flexibly in ways that enable learners to extend understanding and expand the range of their

interpretive possibilities through access to powerful connections" (p. 4).

Lee S. Shulman (1986) was among the first researchers who came with the new way of thinking about teachers' disciplinary knowledge. He attempted to make distinctions about the types of knowledge the teacher needs for teaching in his conceptual theory of pedagogical content knowledge (PCK). According to Shulman, PCK "goes beyond knowledge of subject matter … to the dimension of subject matter knowledge for teaching [author's emphasis]" (p. 9). Ma (1999), in her work of profound understanding of fundamental mathematics with an emphasis focusing on 'know how' found the teachers' need to know specialized mathematics (PCK). Ball, Thames and Phelps (2005) practice-based study highlighted the important distinction between the mathematical knowledge the teachers need and the mathematical knowledge other specialists like engineers, mathematicians, physicists, and chemists need. They found that teachers' mathematical knowledge is enacted in their daily work and involves unpacking/decompressing of content.

Davis and Simmt (2006) conceptualized mathematics for teaching through theoretical discussions of teachers' mathematics for teaching using complexity science framework. They viewed the relationship between teaching and learning as inherently nested with learning as collective endeavour. They report four nested intertwining aspects of mathematics for teaching as mathematical object, curriculum structure, classroom activity, and subjective understanding. Davis and Renert (2014) in their work developing and using concept study found that teachers must have profound understanding of school mathematics. Theorization about mathematics for teaching is an important enterprise in making sense of the complexities involved in effective teaching of mathematics. The outcomes of such theorizations could improve the teacher education, teacher professional development programs, teaching and student learning of mathematics.

Concept study as an approach for developing mathematics for teaching

Concept study (Davis & Simmt, 2006; Davis and Renert 2014), has been used by the researchers to develop teachers' mathematics for teaching by working with groups of in service teachers collaboratively that are interested in understanding mathematics better (Davis & Simmt, 2003; 2006). Davis and Renert (2014) describe concept study as "a structure that is intended to provide the teachers with sorts of experiences and attitudes that might cultivate disciplinary knowledge founded on conceptual diversity" (p. 38). As they argue, in conducting concept study the assumption is that it does not matter whether a realization is right, wrong, adequate or insufficient, what matters "it is that personal understanding of a mathematical concept is an emergent form, arising in complex weaves of such experiential and conceptual elements … the objects or agents of the complex system of mathematics for teaching" (p. 58). Further, the teachers' mathematics for teaching through concept study draws on the tacit knowledge and specific experiences of the participants, often accidental knowledge, and not as mastery of a domain of mathematics; and that "teachers' mathematics can be seen as a mode of being that is enacted when teachers approach a new topic, make sense of a student's error, or reconcile idiosyncratic interpretations" (p. 42), and acknowledge that each different study generates its own results. The variation, context and broad range of interpretations of mathematics concepts that exists in any given pedagogical moment is one of the complexities of teachers' disciplinary knowledge, that "demands an open disposition towards mathematical interpretations and meanings present, whether they are rooted in pre-

established formal mathematics; and selected and adapted by teachers to make mathematical concept more assessable" (p. 38). Concept studies are deliberately structured to foreground teacher's knowing/knowledge and teacher's knowing/knowledge of how mathematics is learned.

Research methodology

Davis and Renert (2014) demonstrated how concept study could be used to enhance in service teachers' deep understanding of mathematics needed for teaching. So far there is no research that concentrated on the use of concept study for pre service teachers' mathematics for teaching. My research addresses this gap as it focuses on pre service teachers' mathematics for teaching using a concept study approach. The research question guiding this work is; In what ways does developing mathematics for teaching through concept study contribute to the professional knowledge, skills and attitudes of pre service teachers? Three sessions were conducted with first year pre service teachers in a teachers' college in central Tanzania. Pre sessions included a pre-test interview and questionnaire and a focus group. The main activity was a concept study of a topic from geometry, area. The post sessions included post-test interview questionnaires and a focus group. The pre sessions were conducted for one and a half hours where pre-test interview questionnaire was done for half an hour and focus group for one hour. The concept study was conducted for three hours. The post sessions were conducted for one and a half hours where post interview questionnaires was done for half an hour and focus group for one hour. Ten pre service teachers (6 male and 4 female) in the second month of their first year were selected randomly from the class to participate in the study.

Findings

The pre service teachers' participants misunderstood the concept of area, as well as volume and perimeter in the pre test questionnaires and focus group. For example, response such as "area is the volume of something. It is the perimeter of something. It is an identification of angles and vertices of different figures/objects". However, during the concept study of area, the concepts such as two and three-dimensional figures, surface area, what is pi and many others emerged. In contrast, the pre service teachers' post response such as "area is the amount of the space covered by something. It is the total space covered by of all faces of the figure. For example, the area of two-dimensional figures is different from area of three-dimensional figures" in the post tests, indicated a broadening of their understanding of the concept of area and other related concepts.

The study found that, the collective learning in concept study helped the pre service teachers' deepened their understanding of area and other concepts related to area and how are they related like pi, measurements, volume and many others that contributed to their understanding of mathematics in general. Pre service teachers showed deep understanding of how concept is build in terms of meaning making, how formula related to the concept are obtained, proper use of mathematics teaching and learning materials, how the concept is related to other concepts in mathematics and other subjects, and the applications of the concept in daily environment outside school.

Conclusion and Significance

This pilot study examined the significance of the concept study on pre-service teachers in view of Mathematics for Teaching and its potential for working with candidates in Tanzania whose mathematics may not be very deep in spite of qualifying for Teacher College. The study found that concept study helps pre service teachers' deep understandings of the mathematics concepts and deep understandings of mathematics in general. In addition the study found the pre service teachers could learn the mathematics the teacher needs to know collectively through concept study. Lastly, the study also indicates the pre service teachers' positive changes in attitude towards mathematics learning and built interest in mathematics through concept study. Therefore, pre service teachers' disciplinary knowledge in the eye of mathematics for teaching could be improved by providing the opportunity for the pre-service teachers to explore different concepts their going to teach through concept studies.

The study suggests the incorporation of concept study in the teacher trainings with the purpose of allowing the pre service teachers' deep understanding of the concepts they are going to teach, deep understanding of mathematics in general and proper use of teaching and learning materials. This could be taken as an activity within the curriculum for each individual pre service teacher to perform a certain concept collaboratively with others within the time frame in teachers' training colleges in the presence of their educators. This appears significance, as most of the pre service teachers' participants showed remarkable improvement in understanding of the concept of area, and how the concept is related to other concepts in mathematics and other subjects, and were highly motivated and built more interest in the concept and mathematics in general.

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