

Pre-primary Teachers' Pedagogical Content Knowledge for Teaching Patterns and Measurement: A Review of literature

Venuste Hakizumuremyi¹ and Jean Francois Maniraho²

Abstract

Teachers' pedagogical content knowledge (PCK) increases their capability to select and teach effectively appropriate content that fit the needs of learners while they are learning. This paper presents an exploration of teachers PCK for teaching patterns and measurement in the pre-primary years of schooling – (i.e., nursery through kindergarten). Shulman has demonstrated that use of PCK in teaching leads to increases in learning outcomes of learners. The aim of this study is to explore the PCK required of mathematics teachers in teaching patterns and measurement. Learners are facing difficulties in their conceptual understanding of patterns and measurement due to teacher ignorance and lack of PCK in teaching in these areas. Evidence provided in this paper is basically based on the past literature on integration of PCK in teaching. Without PCK, teachers may face difficulties in teaching of patterns and measurement effectively. Some recommendations that can be used for effective implementation of PCK in teaching and learning science especially for Mathematics are also outlined.

Keywords pedagogical content knowledge; learning outcomes; pre-primary measurement; pre-primary patterns; pre-primary mathematics

Introduction

Pedagogical content knowledge (PCK) is a framework to understand and describe teacher knowledge needed for effective teaching practice. Nowadays, education is focused on competence-based curriculum (CBC) where learners needs more practical than theory. Using PCK is expected to create an impact for enhancing teaching practice by playing important role in educational systems. Pedagogical content knowledge (PCK) introduced by Shulman in 1986, and explained as the combination of teacher's content knowledge with their pedagogical knowledge. PCK is the link between content knowledge and pedagogical knowledge of the teachers in transferring of subject matter in

agreement to the ability and interest of learners. Learners are confused about differentiating patterns and measurement due to teachers may teach wrongly because of lack of teaching material to deliver content effectively. Application of PCK in education has been identified as key element for knowing Mathematics because PCK include knowledge of content and knowledge of pedagogy go hand in hand in teaching and learning. Lack of basic Mathematics skills cause serious problems for future studies (Munn, 1997). Worldwide, focused to improve the quality of education specifically at pre-primary school, this level is where the foundation of basic mathematical skills acquired and can help to solve mathematical problems encountered in daily life. There is a

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proverb said that an early bird, catches an early worm meaning that the earlier you start doing things, the earlier you get skilled and knowledge.

The teaching process is well described as an interaction between teacher, students, and content. Teachers cannot teach what they do not have and understand. Teacher must have required knowledge for helping learners effectively. In Mathematics is a course required reasoning and cooperation among the learners in order to share ideas. The Rwandan curriculum puts an emphasize on knowledge transferable skills and apply the skills learnt in different situations by developing skills, attitudes and values to solve real life problems(REB, 2015). As evidence of lifelong learning. A researcher knows that, education is like a pattern so that there is a logical sequence connecting these levels of education system in Rwanda. The knowledge acquired at this level of pre-primary school is a foundation of the learning process to another step of learning and for that reasons this study focuses on pre-primary education. Teaching at pre-primary school level require more knowledge about pedagogy because as teacher need to relate the content in real life in order to facilitate learning process. At this level of pre-primary school is where the foundation of the future starts. This stage should be given emphasis in order to develop the future learners.

Literature Review

This part of the literature review is concerned with what other researchers found in the field related to this topic. This literature review focused on teacher's implementation of PCK in teaching and learning patterns and measurement.

What is pedagogical content knowledge (PCK) of pre-primary teachers for teaching and learning?

PCK is a key component of the teacher's knowledge about teaching and is based on both content knowledge and pedagogical knowledge. Experiences of teaching also play important role in the development of PCK. Shulman is the first one who develops PCK as a particular form of pedagogical knowledge that professional teachers use to transfer subject matter knowledge to their learners in an effective way(Aydeniz & Kirbulut, 2014). Baxter and Lederman (1999)state that PCK is not only what a teacher knows in teaching particular topic but also what a teacher do in classroom affects the learning outcomes. Shulman state that effective teacher use different representation to accommodate every student in their learning. Such knowledge includes teachers understanding of the content, and how the content is represented in effective way. PCK provide teachers with the knowledge to perceive the way students understand or misunderstand topic as well as the knowledge of representations and instructional strategies.

PCK represents the knowledge teacher's use in the process of teaching. Teacher's knowledge is very crucial elements in effective way of learning. PCK implementation in education systems contributing for better understanding of the content taught. The ability to teach Mathematics content requires general pedagogy, pedagogical content knowledge, and mathematical content knowledge. Shulman (1986) introduces the term PCK and defined as knowing how to organize lessons to make subjects to be understandable for everyone who undertaking Shulman claimed that PCK refers to as a body of knowledge, however knowledge of content and

knowledge of pedagogy helps us to acquire knowledge. Consequently, Shulman (1987) believes that PCK includes knowledge of learners, knowledge of educational context, and knowledge of teaching aids, pedagogical content knowledge (PCK) should be developed for all teachers to teach effectively. Pedagogical knowledge refers to general strategies of classroom management, teaching styles and methods. Effective teachers use more repertoires when they are teaching as best way to accommodate every learner. Teachers with deep and broad PCK who recognize learning as understanding, realize that knowing are not enough to related content knowledge by connecting prior knowledge with new knowledge. Effective teaching happens if teachers integrate all PCK components and apply them to their specific teaching environments.

The Rwandan curriculum emphasizes on knowledge, transferable skills, and applying learned skills in different situations by developing attitudes and values to solve the daily life problems (REB, 2015). Some research on PCK has been conducted in Rwanda, Maniraho (2017). However, some research has been conducted on PCK in pre-primary schools in Rwanda (Benegusenga et al., 2017). Borko and Putnam (1996) argued that new teachers should have a notion of PCK to be aware of teaching and learning. Many studies showed the impact of qualified teachers on student's learning outcome (Rivkin, Hanushek & Kain, 2005). Professional teachers should have good pedagogical knowledge and content knowledge to transmit content effectively (Darling-Hammond & Sykes, 2003). Many people agreed that a professional teacher who knows well content and having a good pedagogy should teach well. However, pedagogical content knowledge (PCK) is one type of knowledge required for effective teaching. Shulman argued that having content knowledge and

pedagogical knowledge does not implies good teachers. He suggested that a teacher needs to master pedagogical content knowledge in order to become professional teacher in a particular content field.

Previous research shows that the new teachers are struggling to present concepts in an effective way to their students because of lack sufficient knowledge about PCK. An effective teacher should give to the learner's real-life examples to relate content in real life. Some research shows that teachers having a good representation of lessons but wrong in the collection of misconceptions learners encountered during studies (Chick, Pham & Baker, 2006). The research carries out pre-service Mathematics teachers about PCK by using tangible objects the result showed that teachers didn't consider the student misconceptions (Bukova-Güzel 2010). There is research conducted by Lim (2007) in shanghai that proved that the success of the teacher is positively correlated with individual PCK teacher's possessed means that the level of the teacher is different. According to (Smith, diSessa & Roschelle, 1993) talking about eliminating misconceptions in classroom teachers must teach correctly the concepts in clear and use the voice effectively. Content knowledge is fundamental in teaching. According to Brophy (1992) explained that when teachers content knowledge is more explicit, they will help learners in their learning achievement effectively as results of lifelong learning. It is true that teacher's deep subject matter knowledge is very crucial in teaching and learning, but content knowledge alone is not sufficient to fit the needs of learners. Professional teachers not only know content knowledge, although know how to teach certain knowledge related to PCK. The implementation of PCK in teaching help teacher in solving student's misconceptions encountered about the subject that they learn. Teacher's plays crucial role in student

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learning without teachers learning cannot take place. Teachers determine what is taught in the classroom and how it is taught, to accommodate everyone in learning activities.

Strategies for teaching mathematics

These the techniques teachers use to make lessons comfortable for everyone who undertaking. In this study, a researcher concerned with the teachers taught in pre-primary schools. Meaning that teacher requires specific pedagogy to deal with young learners. Teacher who possesses PCK and use it in their teaching practice use the following strategies especially at pre-primary school level these techniques include manipulative and games for motivating learners in learning process. These techniques are explained below.

Manipulative in teaching mathematics

Learning mathematics by using practical materials motivate learners to learn effectively rather than abstract learning. According to Stein and Bavolino (2001) Manipulative is best way for helping students to think and reason in more ways that are meaningful by connecting their knowledge in real life while interacting with teaching materials. Manipulatives help students learn by manipulating different objects based on length, size, this help learners to move from concrete experiences to abstract reasoning (Ross & Kurtz, 1993). Many researchers found that manipulative helps learners in their learning in different ways such as motivating students to learn, reduce the level of memorization and make learning fun for all learners and teachers (Moch, 2001).

Using mathematical games

A good way to motivate learners is transform content into games. Playing games in teaching and learning play important role in classroom by motivating the learners to learn

the content. When preparing lessons, teachers should try to include games related to the topic to be taught. Games are fun and can create a context for developing student's mathematical reasoning. Using mathematical games in classroom motivating students in their learning. Research has shown that boys are more competitive in Mathematics games rather than girls (Peterson & Penelope, 1985). These games make learning fun and educational and help to ensure that all students are successful in their learning.

Playing games is necessary in teaching and learning, because it contributes to development of mental ability, physical, as well as social emotional of children (Ginsburg, 2007). The study conducted by Schiro (2004) show that Games help both teacher and learners to make Mathematics enjoyable and helps in problem solving by facilitating children's engagement and learning. Using of games is a good way to teach content and transforming the content into understandable way of teaching. The fundamental purpose of using games should be prepared in the relation to teaching goal. The teaching aids/materials should be prepared based on the nature of content to be delivery in classroom.

Teacher's knowledge and practice

The study conducted in Rwanda the results showed that teachers are not adequately qualified, the majority of teachers of the pre-primary school in Kicukiro District use a teacher-centered approach (Benegusenga, Ntawiha, & Nzabalirwa, 2017). Teacher centered approach is a teaching technique whereby most of the activities in the classroom are done with the teacher meaning that the participation of learners is low which is not good in relation to what competency-based curriculum (CBC) intended for. The results a study conducted in the USA by Lee

(2010) showed that participants in kindergarten possessed a lower level of pedagogical content knowledge (PCK) of mathematics. Professional teachers must not only master the content knowledge but also have sufficient knowledge related to PCK (Kennedy, 1998).

It is reasonable that teachers know more mathematics and have good pedagogical knowledge to teach effectively. In England, Burghes and Geach (2011, p.17) noted that prior knowledge to be an effective teacher of mathematics is that you are confident and competent in what you are teaching. Knowledge of content to be taught in the classroom is very important variables that influencing learning outcome.

Students whose teachers had attended professional development in the past academic year performed significantly better on an interdisciplinary science test (Yang, Liu, & Gardella, 2018). Follow-up analyses suggested that student understanding of the nature of science possibly mediates the positive effect between professional development and student understanding of interdisciplinary science concepts (Yang, Liu, & Gardella, 2018). The focus of teacher knowledge has shifted from separate content knowledge and pedagogical knowledge to (Shulman, 1986) concepts of PCK. It is reasonable to say that the concept of teacher knowledge is dynamic and can change every time, but content knowledge and PCK remain key point for effective teaching. According to Turnuklu and Yesildere (2007) even if there are many factors that may influence the effective teaching teacher play an important role in student learning outcome” teacher is like implement of what is done in classroom. If teachers teach content in abstract way learners will learn without understanding better to learn from concrete to abstract (Fennema & Franke, 1992).

Pedagogical Content Knowledge (PCK) for teaching patterns and measurement

Pedagogical content knowledge is described as the essential skills for teachers in order to develop their teaching quality and strategy. The capacity to teach mathematical content is influenced by general pedagogy, pedagogical content knowledge and subject matter content knowledge. Shulman (1987) stated that there are different categories of teacher knowledge like knowledge of the content, general pedagogical knowledge, and pedagogical content knowledge. He continues described that content knowledge as the knowledge teacher use to deliver content to the learners effectively. General pedagogical knowledge is referred to all teaching strategies used by teachers to fit the needs of learners. There is no best methodology to be used to accommodate every learners the methodology depend on the nature of the learners, and adopted by focusing on interests and abilities of learners (Fennema & Franke, 1992). Patterns help children to know how the things change over time and can help them to predict the future time based on the data we have. Patterns referred to things repeated in defined way. They also help children to learn how to make logical connections with the previous knowledge by using reasoning skills.

Teaching measurement is very fun by providing different opportunities to the students to interact with them by measuring their size. By using different local material help children to understand measurement concepts. All Mathematics concepts are based on patterns and structure as they have logical connections among mathematical content, the knowledge acquired help us to learn another concept. As Warren (2005) asserts, “the capacity of Mathematics focused in relations and transformations which leads to patterns and generalization.

In pre-primary mathematics, most of the patterns children work on involve (i) physical objects or manipulatives that are put in a repetitive sequence (e.g., A B A B A B ...); (ii) geometrical 2-D shapes that are put in a repetitive sequence (e.g., $\triangle \circ \square \triangle \circ \square \triangle \dots$) and growing pattern of number of objects (e.g., $\boxed{\circ\circ}$ $\boxed{\circ\circ\circ\circ}$ $\boxed{\circ\circ\circ\circ\circ\circ}$ $\boxed{\circ\circ\circ\circ\circ\circ\circ\circ}$...). These repeating patterns are particularly important, since they appear again in measurement where we need to use units. Simply, all mathematics is based on patterns and measurement where the knowledge acquired from one-step help to learn another step.

This research is focused on pre-primary school because it is the foundation of education. Playing with repeating patterns provides early opportunities to differentiate and predict the future sequence (Mulligan, 2011). A previous study has shown that young learners learn by duplicating what they have seen and extended into a repeating patterns (Papic, Mulligan, & Mitchelmore, 2011). However, duplicating patterns can be done by strategies of object matching rather than focusing on unit repeated. At school preschool teachers believed that, patterns were very important in daily activities done in classroom by repeating what already learnt for fixing content in mind.

Previous research on early algebra have found that, while learners interacting with teaching materials help learners to make generalizations and increase the capacity of reasoning that reflect on mathematical structure (Carragher, Schliemann, Brizuela, & Earnest, 2006). Patterns providing learning opportunities to look beyond surface features

like object properties for underlying similarities among them (Graham, Namy, Gentner, & Meagher, 2010). Teaching is seen as a way of helping learners in their learning process this means that a teacher is, in some way, a facilitator.

Research Findings

While exploring the previous research using Google scholar and internet for searching on PCK integration in teaching and learning some researcher found that PCK integration in education increase learning outcomes (Ramdhany, 2010). Similarly, for the work of Shulman established that PCK include knowledge of content and knowledge of pedagogy, which is crucial variable for effective teaching and learning. PCK plays an important role in shaping effective teaching. The information collected about PCK integration in education, I analyzed them by comparing the finding, and obtained that integration of PCK in teaching and learning increase learning outcomes as result of using PCK effectively in their teaching. PCK, which contains both content knowledge and pedagogical knowledge, has been found to be essential for the appropriate selection and use of teaching strategies in general education settings. In addition, using PCK can lead to high teacher as well as increasing student understanding as resulting for further effective teaching and learning.

Discussions and Conclusion

By considering, the previous studies related to this topic to find information necessary to respond the research question about an exploration of teachers PCK for teaching of patterns and measurement. Through Google scholar and using internet to search more information on what other scholar have been found on PCK for teachers in teaching. Using PCK for teachers in teaching, to search information help us to answer research

question. This review of literature was done to explore the integration of PCK in teaching and learning patterns and measurement. Based on the finding from different scholar the results showed that PCK is necessary in teaching and learning. Teaching go hand in hand with knowing pedagogy and knowing content as the result from previous study showed that the combination of content and pedagogy to transfer knowledge to the learners contribute better understanding to education system. Learning from the studies reviewed in this paper, we conclude that, previous research is highly important in understanding of PCK integration in education. As a recommendation for all teachers to be effective teachers is someone having combination of knowledge of pedagogy and knowledge of content to be taught. The discussion from this paper contributes for future discussion and direction on PCK implementation in education.

Recommendations

It is recommended for all leaders related to the education system the way to improve the quality of education especially for people responsible for designing curriculum to include games related to the content as we have seen games help learners to learn with understanding and motivate them. Inform the in-service training unit, Teachers training college (TTC), and University of Rwanda College of education (UR-CE) to design an appropriate program to upgrade pre-primary school teachers and make balance between knowledge of pedagogy and knowledge of content as we have seen these two term go hand in hand in teaching and learning to improve learning outcomes.

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