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ARTICLES

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Assessing basic mathematical abilities of grade four learners: A constructivism perspective

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Abstract

Learners in Zambian primary schools learn mathematics as one of the core curricula subjects. It is cardinal for learners at primary level to exhibit basic mathematical skills which are a prerequisite for acquiring skills in complex mathematical abilities. A descriptive case study guided by Jean Piaget's theory of cognitive development anchored on constructivism paradigm was used as research design. The study comprised of 8 learners (4 boys and 4 girls) in grade 4 aged between 10 and 13 who were purposively sampled. The Basic Numerical and Calculation Abilities Test were administered to learners. The findings were that generally, learners demonstrated satisfactory performance in number skills and exhibited challenges on arithmetic skills. The study concluded that learners had problems with calculations, an indication that learners experienced challenges with fluent skills in single digit calculations, number system and calculation algorithms. The study recommended the need to expose learners to activities that enhance digit calculations, number system and calculation algorithms as well as for teachers to use activities that promote multisensory approach when teaching basic mathematical skills to enable learners grasp mathematics skills at primary level.

Keywords*: Assessment. Cognitive. Constructivism. Mathematical skills.*

Introduction

The Zambian primary school curriculum just like most African countries was revised from a content-based curriculum to a competency-based (CBC) or Outcome-based curriculum (OBE) (Mulenga & Kabombwe, 2019). The rationale for the revision of a curriculum was to make it more effective and responsive to societal needs by providing relevant knowledge, skills and real-life competencies for the learners. The 2013 revised Zambian curriculum aims at producing self-motivated, life-long learners, confident and productive individuals, holistic, independent learners with the values, skills and knowledge to enable them to succeed in school and in life (Mulenga & Kabombwe, 2019). It is hoped that exposing learners to such a curriculum may enable learners acquire skills and knowledge for independent living(Ministry of Education Science Vocational Training Early Education (MESVTEE,2013), positive contribution to society and equalisation of opportunities for all, in that a competency-based curriculum seeks to develop higher order thinking in learners and includes all the four higher levels of Blooms Taxonomy, that is; application, analysis, synthesis and evaluation (MESVTEE, 2013). Higher order of thinking in learners does not occur abruptly, but through gradual following the cognitive developmental stages. Based on constructivists' perspective, learners are capable of utilising their cognitive abilities to understand their world.

Mathematics is one of the core curricula subjects taught at primary level in the Zambian school curriculum (MESVTEE, 2013). Mathematics is viewed as a language of individuals who wish to express ideas of shape, quantity, size and order Dunphy et al. (2014) and is used as a means of describing the growing understanding of the physical universe, to facilitate the transactions of the market place, and to analyse and understand the complexities of modern society (Dunphy et al., 2014).However, studies have indicated that performance of learners in mathematics at primary level has not been good in Zambia. The Ministry of Education reported that performance in mathematics among the Zambian learners has been poor and encouraged early grade assessment in mathematics and other subjects (MESVTEE, 2015). The National Assessment Survey (NAS) design to analyse the performance of learners in a curriculum area in Zambia conducted an assessment at Grade 5 level, which is the beginning of the Middle Basic Education in the basic Education System and reported a national mean performance of 39.4 percent in Mathematics in 2008 (Lufunda, 2012; MESVTEE, 2015). Zambia National Education Coalition (ZANEC, 2012) reported the poor performance in mathematics among learners at primary level, the performance which was also depicted in the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III results published in 2011 (ZANEC, 2012). The low trend performance of learners in mathematics based on Early Grade Mathematics Assessment (EGMA) has been consistent (ZANEC, 2012; Examination Council of Zambia, 2013).

Statement of the problem

The reported low performance in mathematics at lower grade levels by the Ministry of Education based on National Assessment Surveys and SACMEQ reports did not indicate particular mathematical abilities of concern, hence the need to analyse learners' performance on various mathematical tasks to ascertain particular areas of strength and /or concern.

Theoretical framework

Jean Piaget (1896-1980) is one of pioneers of constructivism and theory of cognitive development. Piaget (1936) was the first psychologist to make a systematic study of cognitive development (McLeod, 2018). Constructivism is based on the premise that learners actively construct their own understanding by fitting the perceptions of the world into their existing knowledge and understanding. From constructivism perspective, learning occurs in individuals after they have gaining experience and/or understanding from what they learn. Some of the proponents of constructivism include; John Dewey (1859–1952), Lev Vygotsky (1896–1934) and Jerome Bruner (1915-2016). Despite various proponents contributing to the understanding of constructivism as a philosophy, scientists and philosophers such as Dewey (1916), Piaget (1973), and Vygotsky (1978) have different perspectives about constructivism from epistemology and ontology perspective (Suhendi & Purwarno, 2018). Nevertheless, Jean Piaget is regarded as the father of the constructivism philosophical paradigm due to his formalisation of the theory of constructivism through his systematic study of cognitive development in children and remarkable explanations on how knowledge is internalised by learners to help them construct understanding of reality through their experiences and interaction (Adom et al., 2016; McLeod, 2018; Creswell & Creswell, 2018).

The theory of cognitive development by Jean Piaget which is anchored on constructivism philosophy was chosen in this study based on the premise that for learners to exhibit mathematical skills, reasoning is involved and can be exhibited in their abilities to analyse and find solutions to mathematical problems. The theory of cognitive development was helpful in that it facilitated the analysis of learners' scores and performance based on the Basic Numerical and Calculations Assessment test to determine their cognitive levels of constructivism. Constructivism has been used by researchers to establish how learners construct understanding and attach meaning to learning. Dunphy et al. (2014) analysed the concepts of constructivism in their study of mathematics in early childhood and primary education learners.

Purpose of the study

The study sought to assess the basic mathematical skills of learners in grade 4 at one of the primary schools in Lusaka District, Zambia and provide qualitative analysis of individual learners' performance from constructivism perspective.

Objectives

The study was guided by the following objectives;

i. To analyse the performance of grade four learners in basic mathematical skills.
ii. To suggest intervention strategies for enhancing learner performance in basic mathematical skills.

Literature review

Performance of learners in mathematics at primary level

Acquisition of basic mathematical skills by children at an early stage of education is cardinal for subsequent development of complex mathematical skills in later grades. Every child is viewed as having potential and ability to solve mathematical problems, and make sense of the world using mathematics and to communicate their mathematical thinking (Dunphy et al., 2014). Nevertheless, performance of learners in mathematics at primary level in Zambia has not been good. The results based on National assessment as well as regional reports have revealed low performance of learners in mathematics. According to the 2008 National Assessment Survey Report of 2008 reported that the national mean performance of learners at primary level in mathematics was at 39.4 percent (Hamusunga, 2012). The results were consistent with the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) III results published in 2011. The report by the Examination Council of Zambia (ECZ) was not very different despite indicating a decline in learners' performance in mathematics in 2015. The Examination of Council of Zambia (2015) indicated that performance of learners in mathematics based on grade 5 assessment results was at 38 percent, and bemoaned the poor quality of education at primary level.

Studies on learners' performance in mathematics at primary level conducted within Zambia and other countries have shown mixed results. A study by Raoano (2016) among the grade 6 learners revealed that learners lacked of ability to solve mathematical word problems, which were identified as arithmetic skills and reflective skills. Raoano (2016) indicated that learners lacked the ability to read with understanding due to their lack of competence in the language of learning, leading to their challenges solving mathematical word problems.

A comparative study by Tshabalala (2008) to analyse numeracy performance of Grade 3 learners in urban and rural primary schools of South Africa revealed that the overall performance in numeracy of Grade 3 learners in rural schools compared to their counterparts in urban schools was not satisfactory. The study revealed that variables such as language and funding were found to have had an effect on learner performance in numeracy. In relation to mathematical reasoning in learners, a study by Lee et al. (2013) found that learners improvement in mathematical reasoning. The results were attributed to the exposure of learners to the use of Rearranging numerical expressions. Basic algorithm properties such as associative and communicative properties were connected to rearrange the expression and follow exactly PEMDAS in order, resulting in easy development of mathematical reasoning in learners using the mnemonic, PEMDAS (Lee et al., 2013).

A study by Maniraho and Mugabe (2019) on performance of grade 6 learners in mathematics revealed that both the Rwandan and the Botswana learners performed better on place value questions, as well as the only other question involving simple addition and subtraction. The study further revealed variations in learner performance on assessment items requiring measurements and reported that did not do well on a multi-step problem of finding an area of a shape in a grid where the unit square was not one, and that a question on determining time in a different time zone as well as a question of ordering volumes according to size appeared to have been difficult for all the learners.

Concept of cognitive development in relation to development of mathematical skills in children

Jean Piaget was of the view that human beings have the mental structure that undergoes changes when exposed to new information or experiences due to an individual's interaction with the environment and that a child is born with innate tendency to interact with and make sense of their environment (Slavin, 2009; Munsaka & Matafwali, 2013). Piaget's theory cognitive development provides insight on the changes in the reasoning level of children and cognitive processes (Kendra, 2014). Cognitive development is thus the construction of mental processes such as remembering, problem solving and decision making (Plowden, 2000), which occur due biological maturation of individuals and their interaction with the environment (Berk, 2006; Cook & Cook, 2007). Piaget indicated that an individual's mental structure undergoes processes of change namely; *sensorimotor*, *pre-operational*, *concrete operational* and *formal operational* stages (Bremner, 2010; Moreno, 2010), in which a child exhibits different characteristics that reflect activities linked to exploration and understanding of the word.

During each level of cognitive development, a unique level of internal organisation of cognitive structure, analysis, understanding of information and events occurs (Daehler, 2001) due to the interplay of *assimilation* "integration of experiences" as well as *accommodation* which is modification of cognitive schemas based on new experiences (Riegler, 2012), to enable an individual construct knowledge of reality. *Assimilation* is the process of understanding new objects or events in terms of existing schema (Slavin, 2009). Lightfoot, Cole & Cole (2009) refer to assimilation as the process of incorporating new experiences into already existing schemas. Accommodation is adjustment or modification of existing schemas to make sense of new situations (Munsaka & Matafwali, 2013).

According to Piaget's theory of cognitive development, human mental structures are believed to develop in stages. The first stage is *sensorimotor* stage which occurs from birth to 2 years. During this stage, children explore their world using senses and motor skills (Slavin, 2009). The use of senses and exploration of the environment through motor activities help children to understand their immediate environment (Munsaka & Matafwali, 2013). Children are also able to understand that objects they play with or manipulate continue to exist even when they cannot see them, the term referred to as object permanence (Cohen & Cashon, 2003). If children able to develop object permanence, then they are also able to identify and recognise familiar objects in the environment. Identification of objects is key in learning and acquisition of mathematical concepts.

Preoperational stage is from 2 to 7 years. Children in preoperational developmental stage learn to understand the world by physically manipulating objects and use symbols to mentally represent objects (Slavin, 2009), but lack critical thinking despite their language developing at an incredible rate. Children exhibit egocentrism; inability to consider other people's viewpoints and thinking that everyone sees the world the same way they view it (Munsaka & Matafwali, 2013; Slavin, 2009). Experiencing challenges with conservation is also a characteristic of children in this stage, in that they have a challenge to realise that characteristics or properties of an object remain the same even when the shape has changed (Sigelman & Rider, 2006). Characteristic of Centration is also exhibited by children during preoperational stage. This is a tendency by children to pay attention to only one aspect of an object or situation. For instance, children can focus on the height of an object and ignore its width (Slavin, 2009). Challenges with reversibility are also characteristic of children during this stage. Challenges with reversibility are shown by children's inability to perform a mental operation and then reverse their thinking to return to the starting point (Slavin, 2009). The concept of reversibility is cardinal for children to understand the concepts of addition and subtraction in mathematics.

Concrete operational stage occurs between 7 to 11 years. Development of logical reasoning occur in children during this stage and understanding of conservation, but the use of these skills are restricted to familiar situations(Slavin, 2009), implying that children may face challenges to apply their knowledge and experiences to unfamiliar situation. Children are able to understand reality based on concrete or real objects not abstracts. Children develop the ability to place objects in series (Munsaka & Matafwali, 2013; Slavin, 2009), the term referred to as *seriation*. From mathematics perspective, at concrete operational stage should be able to exhibit a skill on nonverbal number sense, which is the mental representation of the magnitude of symbolic numbers or representation of non-symbolic magnitudes (Aunio, 2018). Skill of nonverbal number sense may enable learners to count numbers with understanding (Geary & Hoard, 2001). Counting numbers can be done in a correct standard form left to right (Geary et al., 2009). Besides counting numbers, children should also be able to sequence objects, that is being able to understand how series of objects or activities occur in a logical order (Kumatongo, 2019) as well as possessing the ability to match, recognise compare numbers, add and subtract simple numbers (Sitabkhan et al.,, 2018), because their mental structures have the ability to perform seriation and understand reality on real objects.

Formal operational stage is the last stage of cognitive ability and occurs from 11 years to adulthood (Slavin, 2009), characterised by logical reasoning, understanding abstract concepts and hypothetical situations. Transition from concrete operational to formal operational stage is gradual (Munsaka & Matafwali, 2013), taking years before it can be accomplished fully, implying that children require time to attain certain characteristics of formal operational stage. It also cardinal to note that individual in certain situations are likely to exhibit formal operational skills in one field such as logical thinking in engineering or arithmetic, and face difficulties with logical thinking in other fields (Bernstein et al., 2008). Nevertheless, learners at formal operational stage can exhibit knowledge of number facts, the ability to recall how someone found the answer to a mathematical problem and strategy used (Bana & Korbosky, 1995; Kumatongo, 2019). Learners are also likely to develop abilities to make complex judgments about magnitude (Gersten et al., 2011), as a result of their' development of magnitude comparison and may also exhibit procedural knowledge, procedural flexibility and conceptual knowledge in mathematics (Rittle-Johnson & Star, 2007; Bottge et al., 2007). *Procedural knowledge* is the basic skills on sequencing and steps required to solve Mathematical problems. *Procedural flexibility* is the different ways in which an individual can solve a particular mathematical problem. *Conceptual knowledge* is the ability to grasp mathematical concepts and ideas and apply them to any problem solving situation.

Strategies to enhance learner performance in basic mathematical skills

Teachers can use a variety of strategies or techniques to enhance basic mathematical skills in learners. The use of play, games and manipulatives in mathematics can improve the mathematical skills of low performing learners (Monomen, Aunio & Koponen, 2014), in that games can promote hand-eye coordination, turn-taking, ability to combine objects, spatial skills and motivate learners (Lisi & Wolford, 2002; Munsaka & Kalinde,2017), whereas visual representations and manipulatives help learners attach meaning to mathematical concepts (Kumatongo,2019).

Integration of information and communications technology (ICT) when teaching Mathematical operations can facilitate the development of mathematical thinking in young children. With the support of teachers, parents and more knowledgeable peers, integrating ICT in mathematics can enable the development of skills for number recognition, counting, shape recognition and composition, and sorting (Papadakis et al., 2016),mathematical skills such as classification, counting and number recognition can also be enhanced (Sarama & Clements, 2009; Nunes et al., 2009). A study by Papadakis et al. (2016) on evaluating the mathematical performance of children in Greece using the Test of Early Mathematics Ability (TEMA3), revealed that teaching with tablets compared to teaching with computers contributed significantly to the development of children's mathematical abilities. Using Multisensory approach; abbreviated as 'VAKT' (Visual-Auditory-Knaesthetic Tactile), in which presentation of information is done in different modalities (Murphy, 1997), can be helpful in teaching basic mathematical skills in early grade. The approach can enable learners to see, hear, touch and manipulate objects (Kumatongo, 2019), and subsequently grasp basic mathematical concepts easily.

Some strategies to enhance the performance of learners in basic mathematics can be the use of acronyms. The PEMDAS is an acronym or mnemonic that may help learners to order mathematical operations which stands for Parenthesis, Exponents, Multiplication, Division, Addition and Subtraction. The PEMDAS is widely used in the United States of America (Rahman et al., 2017), whereas other countries such as United Kingdom, Canada and Zambia use the acronyms BODMAS (Brackets, Order, Division, Multiplication, Addition and Subtraction). BIDMAS (Brackets, Indices, Division, Multiplication, Addition and Subtraction) is also another acronym that can be used (Rahman et al., 2017). Ameis (2011) observed that although the acronyms used in solving mathematical problems may help the learners in remembering the order of operations, the acronyms do not develop the concept behind the acronym itself, and that learners may have the general idea of the acronym, but remembering what the letters of acronym stands for may take some time (Lee et al., 2013). It imperative therefore to use strategies that may help learners grasp mathematical concepts with less difficulties in order to build a strong foundation in mathematics during early primary.

Methodology

Research design

This study was be guided by constructivism philosophy and qualitative case study was be used as a research design. A case study was chosen because the study sought to assess the basic mathematical abilities of grade four learners in detail, in context and holistically. Qualitative research is inductive in nature, providing researcher's opportunity to generally explore meanings and insights in a given situation, and to use a range of data collection and analysis techniques that use purposive sampling (Mohajan, 2018).

Target population

The target population for the study was grade four learners at one of the primary schools in Lusaka. Grade four learners were targeted because they formed a transitional grade from lower primary to middle basic level of the Zambian basic education system.

Study sample

The sample size comprised of eight (8) grade four learners (4 boys and 4 girls) in grade 4 aged between 10 and 13.

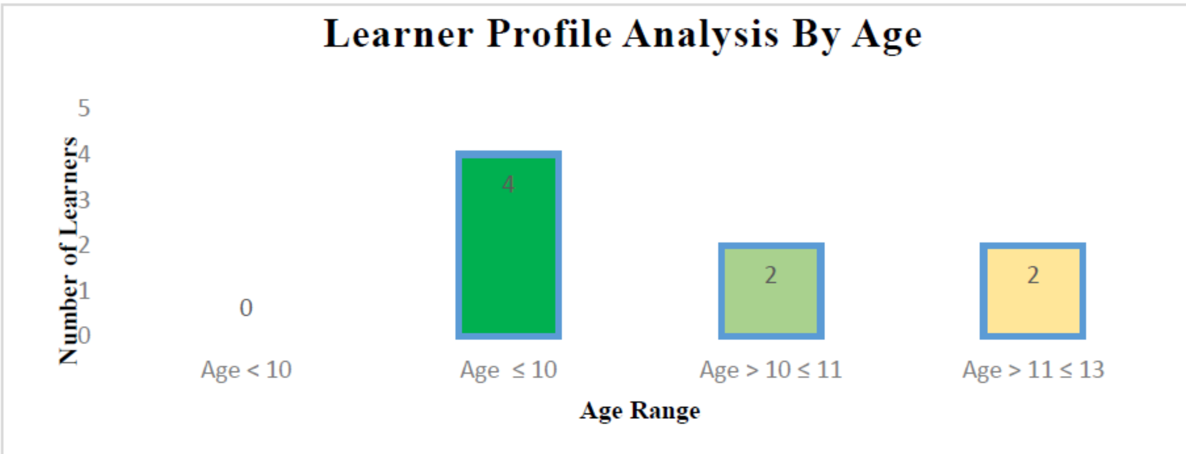

Figure 1: Learners profile analysis by age

Sampling procedure

Participants were selected purposively; this is because purposive sampling is used when choosing participants that have specific qualities to the study (Alvi, 2016). The learners were selected based on convenience in that convenience sampling helps in selecting participants who are often readily and easily available (Taherdoost, 2016).

Instrument for data collection

The Basic Numerical and Calculation Abilities Test (BANUCA) was used to as assessment instrument and was administered to learners in at the same time in a group, but working on individual task. Assessment was conducted in November, 2019 in the third and final term of the academic school calendar. The BANUCA is a Zambian locally developed test battery that can be used to assess learners' basic numerical and calculation abilities. The Basic Numerical and Calculation Abilities Test(BANUCA) is a test battery for assessing basic numerical and calculation abilities for learners in grades 1 to 4 (Räsänen & Chilala,2003), but can also be used for older learners with special educational needs.

The BANUCA tasks are paper based (Monomen et al., 2014), developed for group assessment and screening of difficulties in basic numeracy, and also recommended for assessment of individual learners. BANUCA does not give an estimate of examinee's formal school mathematical skills, despite the tasks in the test battery providing an estimate of a learner's skill in number related abilities, which form the grounds for learning mathematic skills at school and for in daily living(Räsänen & Chilala,2003). Analysis of scores obtained using BANUCA has to more qualitative than quantitative

(Räsänen & Chilala, 2003). BANUCA contains 9 tasks divided into two forms for children at different grade levels. The task contents include; (1) *comparison dots*, a task aimed at assessing learner(s) skills on the concept of more and perceptual estimation; (2) *correspondence task*, which focuses on assessing counting, one-to-one correspondence and Arabic number skills; (3) *single digit addition* task assesses counting from 0 to 20, Arabic numbers and addition abilities, whereas; (4) *single digit subtraction* assesses counting from 0 to 20, Arabic numbers and subtraction skills. Task (5) which is based on *writing numbers* (number line) assesses skills in Arabic numbers, counting above 20, number system and fine motor skills. Task (6) is on *number comparison* and skills assessed include; Arabic numbers, number system, visual attention and memory. Task (7) is on matching spoken and written numbers, focusing on verbal memory and number system. Task (8) is on *calculation of multi-digit numbers* and assesses fluent skills in single digit calculations, number system and calculation algorithms. Task (9), which is the last task, is *arithmetic reasoning* and assesses reasoning and fluent calculation.

During assessment, each examinee is given a test booklet and pencil, while an examiner needs a user's guide and a stop watch for timing the test (Räsänen & Chilala, 2003). The maximum time for doing the tasks is 40 minutes, but depending on the age of examinees, 20 to 40 minutes should be reserved for instructions and other guidance required by the examinees. Each task has a maximum time limit and a word-to- word has to be given to examinees and if the examinee seems to have challenges with instructions when other examinees have started working on a particular task, the examiner can repeat the instructions to an individual without disturbing other examinees(Räsänen & Chilala,2003). The Zambian localised version of BANUCA User's Guide is written in English, but instructions have be translated into Chitonga, Cinyanja, Icibemba, Kiikaonde, Lunda, Luvale or Silozi which are the seven official local languages used in Zambian schools. Standardised and non standardised tools in assessing mathematical skills are of great importance.

The scoring key for BANUCA comprise the level of performance with a three level scale indicated with shades of grey: **Dark grey** for *average or above average performance;* **Light grey** for *satisfactory performance* and **white** for *concern and recommending an learner for further analysis*(see table 1)

Points → Mark scores

	Points	G	OF CONCERN	SATISFACTORY	GOOD
Dot Comparison	5	1	0-3	4	5-6
		2	0-3	4	5-6
		3	0-4	[illegible]	6
		4	0-4	5	6
Addition	8	1	0-2	3-4	5-8
		2	0-4	5-6	7-8
		3	0-5	6-7	[illegible]
		4	0-6	7	8
Corres-pondence	6	1	0-1	2-3	4-6
		2	0-3	4	5-6
		3	0-4	5	[illegible]
		4	0-4	5	6
Sub-traction	4	1	0-1	2-3	4-8
		2	0-4	5-6	7-8
		3	[illegible]	6-7	8
		4	0-6	7	8
Number-line	5	1	0-1	2-3	4-8
		2	0-2	3-4	5-8
		3	0-3	[illegible]	7-8
		4	0-4	5-7	8
Number Comparison		1	0-1	2-3	4-10
		2	0-2	3-4	5-10
		3	0-3	4-6	7-10
		4	0-4	5-6	7-10
Spoken Numbers		1	0-1	2	3-8
		2	0-1	2-3	4-8
		3	0-2	3-4	5-8
		4	0-3	4	5-8
Calcu-lations		1	0-1	2	3-10
		2	0-1	2-3	4-10
		3	0-2	3-4	5-10
		4	0-3	4-5	6-10
Arithmetic Reasoning		1	0-1	2	3-15
		2	0-1	2-3	4-15
		3	0-2	3-4	5-15
		4	0-3	4-5	6-15
Short-forms: Number Skills		1	0-5	6-14	15-36
		2	0-15	16-25	26-36
		3	0-23	[illegible]	30-36
		4	0-26	27-31	32-36
Short-forms: Arithmetic Skils		1	0-3	4-9	10-36
		2	0-12	13-19	20-36
		3	0-18	19-24	25-36
		4	0-22	23-27	28-36
Total Score		1	0-9	10-20	21-79
		2	0-23	24-36	37-79
		3	0-36	37-46	47-79
		4	0-42	43-51	52-79

Summary scores

	Short-forms: Number Skills	Short-forms: Arithmetic Skils	Total Score
Dot Comparison	5		
Addition	8		
Corres-pondence	6		
Sub-traction	4		
Number-line	5		
Number Comparison			
Spoken Numbers			
Calcu-lations			
Arithmetic Reasoning			
Sum	28		

Notes

Calculate summary scores

Table 1: BANUCA scoring key **Source:** Räsänen & Chilala (2003)

Data analysis procedure

Data was analysed qualitatively based on performance scores of learners. Qualitative data analysis technique was used based on the fact that analysis of scores obtained using BANUCA has to more qualitative than quantitative (see Räsänen & Chilala, 2003). The use of qualitative analysis also helps to illustrate the data in great detail and deals with diverse subjects via interpretations (Neuendorf, 2019) suitable for qualitative descriptive studies.

Ethical considerations

Prior to undertaking this study, permission was granted to conduct an assessment by the school administrators. The school manager and teachers from the school where the study was conducted were informed about the nature of the assessment. The learners who took part in the study were also informed about the nature of the study and assured of high levels of confidentiality.

Validity and reliability

Analyses of assessment scores of most learners' ability to solve calculations and arithmetic reasoning tasks were not accurately assessed in that most assessment items were not answered by some learners. However, in reference reliability, the BANUCA test in realiable in that the test battery assesses learners on nine (9) tasks divided into two forms of numbers and arithmetic skills (sse Räsänen & Chilala,2003)for children, indicating consistence of the test battery to assess basic mathematical skills in learners.

PRESENTATION OF FINDINGS

The findings are based on performance of learners on BANUCA test. The tables 2 and 3 indicate the total scores of all learners.

	Learner 1			Learner 2			Learner 3			Learner 4			Ideal
	Short Forms		Total	Short Forms		Total	Short Forms		Total	Short Forms		Total	Full
	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	Battery
Dot Comparison	5		5	2		2	3		3	1		1	**6**
Addition	6	6	6	8	8	8	6	6	6	8	8	8	**8**
Correspondence	6		6	6		6	1		1	6		6	**6**
Subtraction	5	5	5	7	7	7	6	6	6	7	7	7	**8**
Number Line	4		4	7		7	7		7	7		7	**8**
Number Comparison		6	6		4	4		7	7		8	8	**10**
Spoken Numbers			4			4			4			8	**8**
Calculations		2	2		4	4		0	0		3	3	**10**
Arithmetic Reasoning			0			7			8			0	**15**

Sum	26	19	38	30	23	49	23	19	42	29	26	48	
Full Battery	**36**	**36**	**79**	**36**	**36**	**79**	**36**	**36**	**79**	**36**	**36**	**79**	**79**

Table 2: Short Forms Summary Scores Learner 1 – 4.

	Learner 5			**Learner 6**			**Learner 7**			**Learner 8**			**Ideal**
	Short Forms		Total	**Short Forms**		Total	**Short Forms**		Total	**Short Forms**		Total	**Full**
	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	N-Skills	A-Skills	Score	**Battery**
Dot Comparison	6		6	2		2	1		1	6		6	6
Addition	8	8	8	5	5	5	6	6	8	8	8	8	8
Correspondence	6		6	5		5	6		6	6		6	6
Subtraction	8	8	8	5	5	5	6	6	6	8	8	8	8
Number Line	8		8	4		4	8		8	8		8	8
Number Comparison		7	7		2	2		7	7		8	8	10
Spoken Numbers			4			2			4			5	8
Calculations		4	4		1	1		6	6		4	4	10
Arithmetic Reasoning			10			6			9			3	15
Sum	36	27	61	21	13	32	27	25	55	36	28	56	
Full Battery	36	36	79	36	36	79	36	36	79	36	36	79	79

Table 3: Short Forms Summary Scores Learner 5 – 8.

DISCUSSION OF FINDINGS

The performance of learners on BANUCA test as indicated in table 2 in comparison to the ideal scores for a full battery indicated that Learner 1(L1) had 26 on number skills, which falls in the white grid and indicating a point of concern(**see** table 1). The score of 19 out of the total score of 36 on arithmetic skills also indicate a point of concern for a learner in grade four in that score 19 is the least minimum to attract a *satisfactory* rating on the scoring key for learners in grade three (3) and not grade four (4) which attracts a 23 minimum score for satisfactory score, indicating that L1 had challenges with basic arithmetic skills. The score for L1 in arithmetic skills are similar to Raoano(2016) findings which established learners challenges with arithmetic skills. Nevertheless, challenges in arithmetic skills in this context were not attributed to the inability to read mathematical words during assessment (see Raoano, 2016), in that the BANUCA test had no assessment tasks involving mathematical word problems. It was also established that most assessment items involving calculations and arithmetic reasoning were not answered by L1. The performance for L1 on arithmetic skills revealed that the learner had challenges with; fluent skills in single-digit calculations, number system**,** calculation algorithms, reasoning and fluent calculation skills, which are the basic skills assessed under calculations and arithmetic reasoning.

Learner 2(L2) demonstrated *satisfactory* performance on short form of number skill of 30 score and a least *satisfactory* arithmetic score of 23(**see** table 1).The learner draws attention for concern in the skills of concept of more and perceptual estimation for enhancing comparison of dots. Challenges in concepts of more and perceptual estimation are typical of children at *pre-operational stage* according to Jean Piaget's theory of cognitive development (**see** Sigelman & Rider, 2006; Slavin, 2009), implying that the learner's performance on concepts of more and perceptual estimation did not match cognitive maturation in reference to Piaget's theory of cognitive development perspective. The score for L2 on calculations and arithmetic reasoning tasks revealed that the learner experienced challenges with fluent skills, number system, calculation algorithms but performed well on simple addition, subtraction and correspondence related tasks.

The total score for Learner 3 (L3) on number skills was 23 out of the possible score of 36 of the full battery. The results indicate that the learner is performance is within a satisfactory score for learners in grade 3 and not grade four, reflecting need for concern for the learner according to BANUCA scoring key. The results on arithmetic skills is also a source of concern for L3 in that 19 is the minimum score for satisfactory ranking for learners in grade 3. Learner's performance therefore was within the expected satisfactory performance of grade 3 learners both on number skills and arithmetic skills. Analysis of Learners 1's answered assessment items indicated that most assessment items involving calculations were not answered, which may imply the learner's inability to solve tasks involving multi-digit numbers and mathematic reasoning. Exposure to play, games and manipulatives in mathematics **(see** Monomen, Aunio & Koponen, 2014; Lisi & Wolford, 2002; Munsaka & Kalinde,2017), and the use of computer related devices such as tablets (see Papadakis et al. (2016) may be required to help the L3 develop number skills which are prerequisite for developing arithmetic skills.

Performance for learner 4(L4) depicts a *satisfactory performance* on number skills and arithmetic skills. The learner indicated deficit skills in concept of more, perceptual estimation under comparison of dots (**see** table 2). Despite good addition skills, the learner had satisfactory skills in subtraction and number line. Performance of L4 on dot comparison may indicate that the learner might not have had understood the instructions (**see** Räsänen & Chilala, 2003), and the examiner could not have had noticed, in that the child did not show any signs of not understanding instructions. The learner's performance on addition and correspondence tasks indicate a child's capability of performing better on dot comparison. Furthermore, deficit skills were envisaged in computation of multi -digit numbers, reasoning and fluent calculation skills in arithmetic reasoning. Most assessment items involving arithmetic reasoning were not answered by learner 1. Seemingly challenges in arithmetic reasoning may suggest lack of attainment of logical reasoning and understanding abstract concepts, characteristic of learners in *formal operation stage* according to Piaget's theory of cognitive development (**see** Munsaka & Matafwali, 2013; Bernstein et al., 2008).

Learner 5(L5) performed well on number skills with scores of 36 out of the 36 full battery score on number skills falling under *good performance*(see table 3). Performance of L5 on arithmetic skills was satisfactory, implying that L5 had acquired basic mathematical skills, with specific areas of satisfactory performance in calculations and number comparison, good skills in comparison of dots, addition, correspondence, subtraction and number line. The overall score of 61 is a good performance rating out of the 79 full battery.

The performance for Learner 6(L6) falls under the white grid on the BANUCA scoring key (see Table 1), indicating area of concern in number skills. The learner's performance equally exhibited challenges with arithmetic skills with a score of 13 which is a minimum score of satisfactory for learners in grade 2(see Table 1), indicating that L6 was two grades lower in arithmetic skills based on BANUCA scoring key. The specific of concerns for L6 are depicted in almost all the skills outlined in the assessment instrument.

Learner 7(L7) had *satisfactory* performance in both number and arithmetic skills. The good scores on addition, correspondence, subtraction and number line is an indication that L7 had the potential of performing better on dot comparison tasks. However, it might be possible that the learner might not have had understood the instructions (**see** Räsänen & Chilala, 2003).

Scores for Learner 8 (L8) revealed the learners ability to solve mathematical tasks involving number skills in that the learner had *good* performance in number skills. Performance of L8 on arithmetic skills was satisfactory. The good performance on tasks involving addition and subtraction concur with the findings by (Maniraho & Mugabo,2019), although the performance for learners 8 involved more tasks on addition and subtraction as compared to the study by Maniraho & Mugabo (2019). However, the learner has a satisfactory score on arithmetic skills was seemingly as a result of challenges calculations and arithmetic reasoning in which the learner obtained lowest scores.

Conclusion

Generally, learners demonstrated satisfactory skills on number skills and experienced more challenges on arithmetic skills despite differences on individual scores. Most learners did not answer tasks involving calculations and arithmetic reasoning, which may imply that learners generally experienced challenges with fluent skills in single digit calculations, number system and calculation algorithms. The mathematical challenges faced by learners maybe a reflection of their inability to comprehend abstract concepts, and/or inability to solve tasks involving mathematic reasoning.

Recommendations

- Teachers need to use activities that promote multi-sensory approach when teaching basic mathematical skills to enable learners grasp skills in mathematics easily.
- Calculation of multi-digit numbers requires teachers to build fluent skills in single-digit calculations, number system and algorithms in learners as pre-requisite skills.
- Teachers should employ a task phase assessment approach for learners with challenges in the concepts of more, perceptual estimation to enhance dot comparison.

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