Teaching Subitizing in Early Childhood Education Centres in Lusaka Urban, Zambia

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Abstract

The study aimed at analyzing the way subitizing is taught in Early Childhood Education Centres in Lusaka urban in Zambia. Using a mixed approach paradigm, qualitative and quantitative methods, a collective case study was conducted. The questionnaire was used to collect quantitative data. The qualitative data was collected using semi-structured interviews, focus group discussion (FGD) meetings, classroom observations, documents and records analysis. The findings from the study revealed that teachers do not understand or use the term subitizing and the topic was not reflected in any of the teachers' prepared documents such as lesson plans, daily schedules, and schemes of work.

Keywords: Subitizing, methods, strategies, teaching/learning materials, early childhood teacher, early childhood centre.

Introduction

Quality of Early Childhood Education (ECE) teacher education and process of teaching children subitizing can be observed and measured. This means the quality of teaching and care given to children can be observed and measured too. Quality in this context is viewed as having two major components: structural and process. In this study, quality ECE teacher education and learning in ECE centres refers to experiences that enhance social, cognitive and emotional development of children (Howes and Droege (1993). Structural quality components include type and size of classroom; toys and items that surround children; an ECE teacher who is available, responsive and sensitive to mathematics and other needs of children. In addition , theoretical knowledge on subitizing acquired from the ECE colleges of education including the ECE teachers' beliefs on how young children should be taught also contribute to the structural components of quality teaching in ECE. Scholars define process quality as experiences of children while they are in the care of adults (Helburn, et al.1995; Smith, 1987; Schweinhart and Weikart, 1997; Carr 2003; Podmoreet al., 1998; Dahlberg,et al.,1999; Rowe and Wertsch, 2002). Between structural and process quality, an agreement among a number of scholars exists (e.g. [Kontos and Wilcox 1997; Lamb, 1998; Mead and Hendricks, 1999) that process quality is the most important aspect of quality. It contains components like interactions between the child and the ECE teacher as well as the opportunities present in the environment. According to Bredekamp and Copple (1997) process quality is "one that provides a safe and nurturing environment that promotes the physical, social, emotional, aesthetic, intellectual and language development of the infant while being sensitive to the needs and preferences of parents".

ECE teachers have a potential of offering quality learning opportunities in subitizing in the ECE centre context if they have a strong educational and theoretical base, and understand the theories that underpin child development and learning. This includes conceptualizing subitizing and numerosity as understood in early childhood education. Manning-Morton (2006: 45) argues that skills required for ECE teachers are highly specific and include a "broad theoretical knowledge, a deep understanding of individual children and a broad high level of self- awareness".

1.1 Early childhood teacher subitizing

The Universal Declaration of Human Rights and the United Nations (UN) Declaration on Rights of the Child attest to the need for Early Childhood Education. The Government of the Republic of Zambia (GRZ) through the Ministry of General Education believes that early childhood education is of great importance to all children and for national development as a whole.

For this reason it should be made available to all eligible children in Zambia. Early childhood education provides a sound basis for learning and helps to develop skills, knowledge, personal competence and a sense of social responsibility. For this reason every child should have access to good quality ECE. Education International (EI) in 1998 passed a resolution to lobby for the provision of quality ECE to every child, free of charge and to improve conditions of educators working in this sector source!. It is for this reason that the Government of the Republic of Zambia decided to give priority to ECE and increase access to quality (ECE) avoid repeating same words/concepts in a sentence provision. Currently 1, 849 ECE centres have been established in the existing primary schools with a total of 124,046 children in attendance. This number excludes privately owned ECE centres and children attending therein. The government has also deployed 1,252 ECE teachers to public ECE centres throughout the country. However, access to ECE still remains low, standing at 29 percent of all eligible children in Zambia (Ministry of General Education 2016). Additionally, there was vigorous campaign and sensitization of the masses throughout the country by Zambia National Education Coalition (ZANEC) in 2016, Dubbed "The Bus Campaign" on ……..?

Numeracy skills are one of the foundations for success in learning. The basis of numeracy is the ability to subitize numbers. Subitizing is the ability to 'see' a small amount of objects and know how many there are without counting. Subitizing is what makes children know the number rolled out on a six sided dice, the number of stones in a hole as they play Insolo or chiyato (Zambian traditional games) the number of seeds to plant in one hole. In the ethnic groups that keep animals, young children know just by looking how many animals are in the pen, how many have gone out for grazing and how many have returned without counting. They would know immediately if an animal was missing. Subitizing is responsible for making adults not to count the pips after playing board games for a while. Subitizing is a fundamental skill in the expansion of learners' understanding of number (Baroody 1987:115).

The patterns specify them recognized are used to discover properties and skills such as conservation, compensation, unitizing, counting on, composing and decomposing numbers, as well as understanding o arithmetic and place value. It is therefore important for ECE teacher Education Colleges to help student acquire these skills as well as the strategies for teaching them to young children in pre-schools. The training of (ECE) teachers in Zambia remains a priority in recognition of the vital role well-trained professionals play in the quality of early childhood experiences for children zero to eight years. Early childhood teacher preparation and professional development in Zambia also entails helping all teachers gain knowledge and practice skills that contribute to the educational achievement of all children. This includes all developmental domains, mathematics being one of them. Despite all efforts that have been made, significantly less attention has been given to the process of development of children's acquisition of the skill of subitizing by early childhood teacher educators or researchers. The National Numeracy Framework (2016) addresses many concepts in numeracy and suggests strategies for teaching these to ECE young children; however, there is no mention of the relationship between subitizing and the process of developing numerosity.

In order to help teachers understand what and how children are expected to learn in mathematics and how these mathematics concepts should be taught, Zambia Association of Mathematics Educators (ZAME, 2016) have been organizing workshops and have developed guidelines for teachers to use. They also play an important role in the development of reference and resource materials for early childhood teachers to use. Given the development of these guidelines and materials, it is possible to assume that there is significant agreement on the knowledge needed for teaching young children numeracy. There is, however, a lack of agreement on the content of what early childhood teachers actually need to know to teach numeracy to very young children. Efforts to harmonize this situation was made by developing the new National Curriculum Framework (2013) and National Early Numeracy Framework (2017). Both these national documents do not use the term subitizing but mention counting.

Research on infants suggests that young children spontaneously use subitizing to represent the number contained in small sets and that subitizing emerges before counting (Klein and Starkey, 1988). However, other scholars have disputed this thought. Beckmann (1924) discovered that younger children used counting rather than subitizing (cited in Solter [1976]). On the other hand some scholars agree that children develop subitizing later, as a shortcut to counting (Beckwith and Restle 1966; Brownell 1928; Silverman and Rose 1980). This perspective shows that subitizing is a form of counting swiftly (Gelman and Gallistel 1978).

This notwithstanding, "Subitizing is a fundamental skill in the development of Children's understanding of number" (Baroody 1987:115). Children use pattern recognition to discover essential properties of number, such as conservation and compensation. They can develop such capabilities as combining, counting on, and composing and decomposing numbers. It also helps them in understanding arithmetic and place value. All these are valuable components of number sense. It is for this reason that early childhood education (ECE) teachers should understand the concept of subitizing and how to best to teach it in ECE centres. This study examines how subitizing is taught by ECE teachers in ECE Centres in Lusaka urban in Zambia.

The present study aims at examining the early childhood teachers' teaching strategies that help young children subsidize numbers and develop numerosity. It is also aimed at evaluating ECE teachers' ability to organize numeracy "learning centres" in their classrooms. Teachers and parents do acknowledge how wonderful it is to watch children develop confidence in these skills, and how heartbreaking it is when they fall behind. Therefore, it is important to look at the pedagogical strategies that are aimed at enhancing subitizing as a foundation of developing numeracy skills in the early childhood. There are a number of strategies used to teach subitizing in ECE centres. However, their appropriency for teaching subitizing in ECE centres in Lusaka urban is not been interrogated.

Children in early childhood are naturally curious and develop a range of mathematical ideas before they enter pre-school. Children make sense of their environment through observations and interactions at home, in ECE centres and in the community they live. Mathematics learning is embedded in everyday activities, such as playing, reading, beading, baking, storytelling and helping around the home. Activities can contribute to the development of number and spatial sense in children. Curiosity about mathematics is fostered when children are engaged in, and talking about, such activities as comparing quantities, searching for patterns, sorting objects, ordering objects, creating designs and building with blocks. Positive early experiences in mathematics are as critical to child development as are early literacy experiences. Studies support the notion that cognitive development among Zambian children occurs in a sociocultural mediated contexts through games and play (Piaget, 1962; Vygotsky, 1978; Mtonga, 2012; Mukela, 2015). Play, being a sociocultural mediated activity, serves a number of different functions, the most outstanding being a mechanism for enculturation of children. Play facilitates holistic development and provides opportunities for children to learn not only the social and cultural values but also the skills and competences necessary for survival and become productive members of their communities. Indigenous knowledge has been singled out as the foundation for problem- solving strategies for local communities especially in the poverty stricken rural areas. This indigenous knowledge is the consequence of practical engagement in everyday life and is a product of many generations of intelligent reasoning, and that it has been instrumental in sustaining the survival of the local communities (Senanayake, 2006).

Mtonga (2012:1) observed that: "Every national, ethnic, and cultural group had its own wealth of children's play and games which had great educational values. There are games and play activities that promote subitizing in Zambia. Among the Bisa people of Chief Mwanya in Lundazi district, parents, cousins, aunts and older siblings make custumes for dances. One faviourite one is the nzombo (A form of rattle won around the ankles). The nzombo make sounds as the legs are moved according to the rhythm of the music being played. The nzombo is made from wild fruit with a hard cover. The seeds and liquid from this fruit are removed. The round shell is dried. Later stones are put inside and sealed. A number these round shells are stringed together so that it fits a particular child's ankle. There is no audible counting but both the children and elderly memebers of the ethnic group know how many seeds or stones to put inside the nzombo and how many nzombos are enough to go round a particular ankle. They sound produced by the nzombo is tested by the child stumping the ground. When the nzombo are dry and produce the desired sound. The villagers would use them when dancing. Children subitize the number of seeds and the shells of the wild fruits used to make the nzombo. The steps for dancing are also counted without naming the numbers. A harmony is created through songs, drums, body movement especially the movement of the feet which produce a pleasing sound the nzombo tied around the ankles. Nsolo and the chiyato played using stones are also traditional games that promote subitizing in young children as the y play the game.

This study provides valuable information to the government, non-governmental organizations (NGOs), the communities and parents in general on the importance of using appropriate methods, strategies and teaching and learning materials by ECE teachers in order to improve the learning outcomes in subitizing and consequently numeracy.

ECE teachers whose teaching and early stimulating activities are based on sound theoretical knowledge and practical skills are more likely to motivate children to engage in subitizing activities. This is very important as activities done to and with young children have a lifelong effect on their learning. In short this is an area for investing not only time but money. A Bemba saying in Zambia goes like this, "Imitiiyikulaempanga" (A forest develops from seedlings).

Purpose of the study

The purpose of this study was to examine how teachers teach subitizing in ECE Centres in Lusaka, urban in Lusaka.

1.0 Research questions

The following are the research questions guiding this study:

a) What methods of teaching do ECE teachers use to teach subitizing to children in early childhood?
b) What strategies do ECE teachers use to teach subitizing?
c) What traditional games are used in ECE centres to teach subitizing?

2.0 Methodology

This study used a mixed approach with quantitative and qualitative methods used for data collection in order to interrogate the teaching of subitizing in early childhood centres in Lusaka urban in Zambia. The mixed method was adopted in order to thoroughly understand how subitizing is taught in ECE centres by triangulating the results.

According to Hughes (2001), a paradigm reflects the underpinning assumptions of the nature of knowledge and the best way of understanding the world. The choice of the paradigm for any research underpins the methodological approach taken in the research and this in turn, influences the methods that are chosen for conducting the research. According to Hughes (2001), Burton and Bartlett (2005) and Sobh and Perry (2006), a research paradigm reflects the choice of methods and the type of knowledge they generate. Mukherji and Albon (2012) noted that any piece of research has a philosophical basis, which links to the way knowledge is viewed and appropriate methodologies to use in research. According to Kombo and Tromp (2006:99), data collection refers to the gathering of information to serve or prove some facts. Questionnaires, interviews (Focus Group Discussion (FGD) meeting, Key Informants Interviews (KIIs) and personal interview), observations, document and records analysis were used as data collection strategies. These techniques of collecting data were considered because they were more likely to yield a great deal of information about the teaching methods, strategies and games and play activities used by ECE teachers to teach subitizing in ECE centres. Triangulation would also be ensured. Quantitative data was analysed using statistical package for social sciences (SPSS version 25) while themes that emerged from qualitative data were categorized and analysed using Braun and Clarke's guide to the 6 phases of conducting thematic analysis (2006).

3.0 Results

3.1 Methods and strategies of teaching subitizing.

There are essentially two different ways of understanding teaching. The first looks at teaching as a teacher-centered activity in which knowledge is transmitted from someone who has acquired that knowledge to learners: teaching as knowledge transmission. The second perceives teaching as a learner-centered activity in which the teacher ensures that learning is made possible for learners and supports, guides, and encourages them in their active and independent creation of new knowledge: teaching as assisted knowledge creation. Teaching involves the use of specific methods. These could be contemporary or traditional. Nsolo is one of the traditional methods respondents found to be able useful in teaching subitizing to children in early childhood. Nsolo by nature is a child centred method since the learners learn by actively participating in the activity. This is supported by researchers in the field of education and psychology such as Vygotsky and Piaget who state that children are not passive recipients of knowledge but active investigators and constructors of knowledge. There is a lot of evidence that support the view that a learner-centered approach has positive consequences on learning (Darling, 1994). Specifically, the child-centered approach, or what Darling (1994) refers to as the Child-Centered Pedagogy (CCP), promotes learner participation. This approach allows Children to become more open and more efficient at making decisions on their own, and it also recognizes that interactions between teacher and learner are natural, thus breaking the psychological barrier whereby learners see their teachers as experts (Darling, 1994).

Another important consequence of the child-centered approach is the notion of cognitive processes. What is to be learned is determined by the child's understanding at the precise moment and knowledge is built upon and constructed on what the learner already knows. Respondents were asked to indicate the methods used to enhance subitizing and the results are in Figure 1 which show that 45 percent of the respondents found Nsolo to be a useful method in teaching subitizing, while 40 percent considered the dice to be very useful and 15 percent indicated dotted cards as useful.

3.1.1 Key Informant Interviews (KIIs)

Analyzing the discussions with key informants the following views were summarize: "When teachers are asking children 'how many balls can you see? They are encouraging children to subitize." "While showing them a picture of objects on flash cards, they are teaching subitizing. They just don't know the term." "All the charts teacher put in their classrooms and used for oral counting, can also be used to teach subitizing." "Most games involve subitizing. For instance number domino and chiyenga.""We need to use the term subitizing more because we are already teaching it without conscious knowledge of what we are doing.""We need to understand the difference between subitizing and counting."The KII revealed the fact that subitizing is embedded in the teaching of counting but the teachers do not know the term and therefore do not deliberately plan for it or teach it.

3.1.2 From the FGD came such comments:

"Nsolo teaches children how to count. The mind of the child critically learns to follow things. In fact some children have learnt how to count from doing Chiyato and Nsolo. By the time the child goes to school, s/he has already learnt how to count."

"Nsolo helps one to think critically. For children to do Nsolo, they should be very accurate and that accuracy entails them to have a goal."

"Nsolo teaches children how to count and follow what is happening."

"Nsolo increases one's knowledge in mathematics."

"In a very short period of time, the child playing nsolo has to know how many stones should remain in the hole. In this way the child understands numbers fast."

None of the respondents used the term subitizing.

3.2 Materials used for teaching subitizing

Teaching aids are materials used by the teacher when explaining or teaching children. These could be materials placed in the numeracy corner to help children acquire subitizing skill. There should be no abstract teaching with children in early childhood as research has established that children learn better when they are manipulating objects. These teaching aids could be stones, sticks, dotted cards, blocks, dice, and puzzles. On the other hand learning aids are a support to teaching strategies which assists learning. Learning aids are materials used by children while the teacher teaches. Learning cannot take place if learning aids are absent. It would be difficult for teachers to organise learning corners with materials for children to interact with. In this study the variable of teaching materials used for teaching the concept and skill of subitizing was tested by asking the respondents to name the teaching materials they used during teaching. The results that are presented in Table 1 indicate that almost half (47.5 percent) of respondents said the teachers use dice, 10 percent said that they used dotted cards and flash cards to teach subitizing**.** However, this was contradicted by the results from interviews, observations and document analysis which revealed that the teachers did not know what subitizing is and therefore did not plan or teach it.

3.2.1 Document analysis

Document analysis was used to establish the teaching materials used to teach the concept and skill of subitizing. It was revealed that while the document analysed did not mention subitizing, there were materials used to teach counting which could also be used to demonstrate subitizing. The teachers were categorical that the materials mentioned were for teaching counting as it was the first topic in the curriculum and syllabus. The materials mentioned were dice, dotted cards, dominoes picture cards and flash cards. 40 percent of the respondents mentioned sticks and stones in their lesson notes**.**

3.2.2 Traditional games and play as an approach for teaching subitizing

A study conducted by Mukela (2015) revealed that indigenous play and games had many educational benefits underpinning them which were potentially valuable for promoting children's cognitive and social abilities.

In the area of mathematics skills, children who constantly participated in indigenous games like nsolo (a game that involves the movements of stones in dug out small holes), and chiyato (a game involving throwing of a stone in the air while simultaneously scooping some stones back and forth in a small dug out hole) had the potential to improve the children's subitizing and numeracy skills. The games stimulate the use of higher order cognitive skills such as analysing, planning, logical thinking and problem solving. The games are also likely to promote conceptual and perceptual subitizing as well as child-to-child interpersonal relationships as children talk to each other as they play and remind each other of the rules of the game. Children's psychomotor development and eye-hand coordination is another possible development. Playing games is a great way to engage young children in subitizing activity. Engaging the learners in discussions about their thinking as they play games serve as useful assessment and instructional tools. According to MacDonald (2013), when playing subitizing games, it is advisable to begin with orientations that children are familiar with before introducing new orientations or larger quantities. All pre-school children should be capable of subitizing items as large as two or three, so these would be excellent initial quantities. To assess this variable, respondents were asked to name the traditional games they used in order to teach subitizing skill and concept amongst pre-school children in their classes. The results obtained revealed that Zambian traditional games had many educational benefits which were potentially valuable for promoting children's cognitive and social abilities and more specifically the ability to subitize. For instance, it was strongly suggested that constant participation in traditional games like nsolo (a game that involves the movements of stones in dug out small holes), and Chiyato (a game involving throwing of a stone in the air while simultaneously scooping some stones back and forth in a small dug out hole) had the potential to improve the children's subitizing and thus numeracy skills. In the process of play the children use visual or perceptual subitizing and they move the correct number of stones without pausing to count. The games also stimulate the use of higher order cognitive skills such as logical thinking, planning, analyzing and problem solving while playing these games.

From the KIIs it was clear that subitizing was involved when children are playing chiyato. And that it should be encouraged in all ECE centres. Some of the responses that stood out are written below: "The children can learn the concept of addition and subtraction. The children without counting know how many stones to push back into the hole and how many to leave. Depending on whether they are in *mwana* (level of the game determined by the number of stones a child is supposed to leave out) one or two." (Zambia Association of Mathematics Educators [ZAME] chairperson)

"A person may gain some skills in counting through chiyato.*" (Continuous Professional Development [CPD]* coordinator)

*"*Chiyatohelps children to know how to count (non-verbal) especially the one for 12 stones. A child first begins to take 2 stones into the hole, then 3 stone and so on". (Grade level team leader)

The head of Mathematics department at Kasama College of Education's views on the teaching of subitizing using a traditional game like chiyato said: "The game demands concentration, eye-hand coordination, visual discrimination and dexterity. There is addition and subtraction involved in the game. I also think it builds the learner's thinking capacity in that it helps the learner to think and move stones fast before catching the stone that was thrown into air. The learner's motor thinking and skills are developed". "What I normally see when the children are playing *Chiyato* especially the one involving twelve stones is that children learn multiplication in that game. This is because they have to first begin by taking one stone at a time, then two, three and so on."

According to the key informants, organisation of various mathematical skills is achieved through a psychological process of making additions, subtractions, while throwing the stone in the air. The fundamental skill needed here is subitizing which helps the child to quickly push the correct number of stones in the hole before the stone that was thrown in the air lands. Should this happen the child will be disqualified.

3.2.3. Nsolo

Nsolo is a traditional game involving the movement of some stones/seeds from one hole to another. The game involves two players at a time who are expected to face each other and make their movements in opposite directions to each other. These movements are done in small holes arranged in about four vertical lines (or columns) and eight horizontal lines (or rows) respectively. Horizontal lines can sometimes go to about 12. Players agree on the number of seeds to put in the holes.

When the seeds being moved end in an empty hole on the side facing the other opponent while the opponent has some seeds in those direct holes on his side, then such seeds are declared captured**.** Findings obtained from key informants on the benefits of playing nsolo (stone passing) were that this games had the potential of enhancing children's numerical skills. Playing such games required children to engage in logical thinking and problem solving strategies to obtain desired results. They also subitize as they move the stones from one hole to the other. Social interaction among learners was also another element cited by some informants as being a prominent feature in playing nsolo. As a result of the social interaction created, children easily engaged in relaxed social mood and learn mathematical operations without realizing it. Tembo (1987) a traditional games writer, carried a mathematical analysis of nsolo and found that: a) The Nsolo game uses simple subtraction, addition, and multiplication of stones; b). The game uses natural numbers as contrasted to whole numbers, as the concept of zero does not seem to exist. All the holes are always counted even though they may be empty; c) The counting, piling up, and adding stones strategically seems to mimic the use of exponentials. For example, a hole which has 3 stones suddenly becomes more powerful with the strategic addition of 1 more stone to make it 4 in order to score on an opponent; and d) the game seems to be linear as players never skip a hole and at the same time cyclical in structure. This study established the fact that ECE teachers were not making good use of the game most likely due to the fact that they do not understand the value of the game in promoting subitizing and its role in the development of number sense in young children.

4.0 Conclusion

The study concluded that materials being used by ECE teachers to teach counting could also be used to teach and enhance the concept and skill of subitizing. Using flash cards, dominoes, picture cards, and traditional play and games as teaching materials and methods by ECE teachers should also be adopted to teach Subitizing. The learning corners were not evident in the ECE classrooms where children could interact with prepared materials that could help them develop subitizing. Children enjoy playing games and Zambia is blessed with many traditional games. It is therefore important that the games that could be used to teach subitizing be documented and used in ECE centres. Research is continuously bringing up new information and knowledge about the importance of subitizing and how best to impart knowledge on subitizing to young children and its overall effect on achievements in numeracy and mathematics. It is therefore very important that continuous professional development for ECE teachers is provided. This study found that subitizing is not taught, which creates a gap in the development of number.

This study therefore adds a new dimension of looking at the planning of the teaching of mathematical concepts. It is recommended that instead of starting with counting it should emphasized the concept of subitizing should be given prominence in the process of developing of number sense in preschool children. The innate ability of children to 'instantly know the number' of items presented before them should be used as a base base. This means the Government of the Republic of Zambia, through the Curriculum Development Centre should consider including subitizing in all teaching and learning material for ECE teachers.

Tables and figures

Table 1: Materials used by lecturers to demonstrate subitizing. Let this table be part of the the results and explain its content. It forms part of the quantitative data

		Frequency	Percent	Valid Percent	Cumulative Percent
	Dominoes	1	2.5%	2.5%	2.5%
	Dotted cards	10	25.0%	25.0%	27.5%
	Dice	19	47.5%	47.5%	75.0%
	Flash cards	10	25.0%	25.0%	100.0%
	Total	40	100.0%	100.0%	

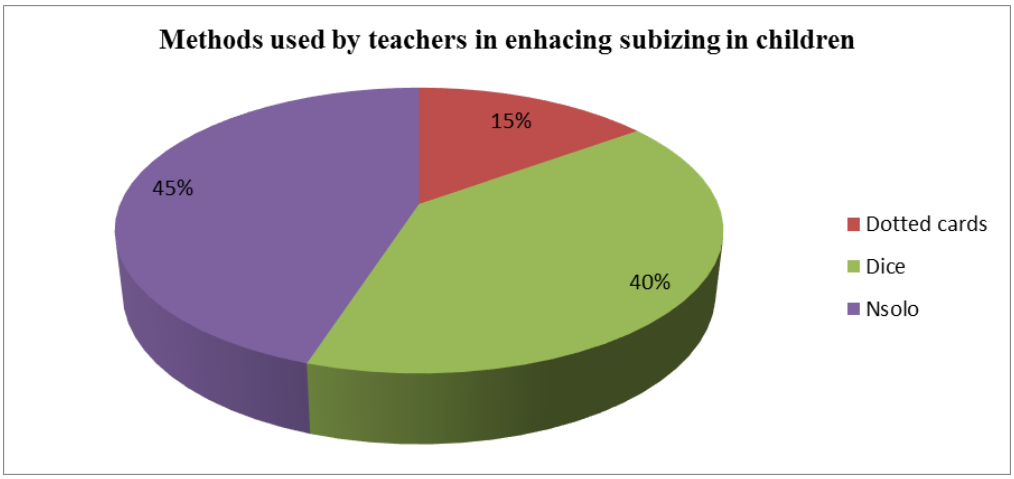

Fig. 1: Methods found useful in teaching subitizing

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