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DEMYSTIFYING MATHEMATICAL OPERATIONS: LEVERAGING ON THE POWER OF TRADITIONAL GAMES

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Abstract:
Teaching and learning mathematics as a subject has for a long time been a difficult task to both learners and teachers. A great percentage of learners hate mathematics which has led to a high rate of failure in this subject as compared with other subjects at Grade seven and 'O' level. Literature content on motivation asserts that once a task is difficult to accomplish there will be low level of motivation and burnout often develops as a result of not succeeding. Modern teaching and learning methods recognize interactive methods as effective especially in science subjects like mathematics. African traditional games are in this study regarded as interactive approaches which have relevant inclusion of every participant in the learning process. Data transcription and thematic coding were expressed on tables and graphs for analysis purpose. This study could assist mathematics teachers in primary and secondary schools in their endeavour to motivate learners into loving mathematics through harnessing the power of traditional games in manipulating complex tasks that fall under the four basic operations i.e. addition, subtraction, multiplication and division etc.. The study observed these objectives: i) identifying traditional games that teach the four basic mathematical operations, ii) explaining the advantages lying in traditional games when teaching and learning mathematical operations at primary level, iii) identifying the mathematical myths that demotivate learners. The study concluded that traditional games like *nhodo*, *tsoro*, *pada*, and *madhadha ari pamutsetse* are some of the most effective and interesting games in the teaching and learning of mathematics in the primary schools. Regarding the use of traditional games in the teaching and learning process as primitive approach,

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has contributed to several mathematical myths. It has been recommended that mathematical concepts are easily grasped by a learner who is motivated to learn and learn new concepts through familiar activities. Mathematical teaching approaches must include traditional games. Since traditional games are basically interactive, they should be the cornerstone to the teaching and learning of mathematics as a subject. The teaching of mathematical operations should not be left to teachers alone but parents should also take part introducing to their children some traditional games found in the community and homes.

Keywords: traditional games, mathematical operations, interactive, learner

1. Introduction

The ever growing numbers of students dropping mathematics, enrolling for mathematics bridging course, those not studying mathematics and those who fail mathematics is a cause of concern to parents and among the learners themselves. Smith, (2004 in Tiris, 2008), argues, "*Mathematics is vital, it underpins research and development in the sciences, technology and computer world, it is a key driver of economic and labour market growth and it provides a set of key skills*". The centrality of mathematics to economic and technological development of a country is not questionable. In the history of education, civilization in Mesopotamia and Egypt included calculations using numbers, gave birth to calendars, angles and graphic representations is testimonial to importance of mathematics today, but were basing their civilization on indigenous knowledge. Therefore, growing figures of learners without this essential subject remind educators of a great need of harnessing several forms of creativeness in the pedagogical approaches. One of these approaches earmarked in this study is the use of traditional games to learners in the primary and secondary school levels.

Recent researches conclude that all learners are capable of learning all of the mathematical concepts we want them to learn, and they can learn if it make sense to them and if they are given chance to do so, (Walle, 2004, in Nyikahadzoyi, 2012:21). The bottom line from psychologists like Triplett, (1898, the founder of social psychophysiology and sport psychology, in Gross, (2010, p484, Maslow in King, 2008) is that motivation plays a key role in the learning process of the learner. This point facilitates a better place for the learner to be interested in the learning of a concept even it is difficult. Sport games are found to have that power to motivate a learner, but it calls for the creativeness of the teacher to harness the power of those traditional games and convert the activities into mathematical operations.

Efforts by the Zimbabwean government through the Ministry of Education to motivate every learner to pass mathematics have yielded very insignificant numbers in schools, for instance, passing a policy that says no one should enroll as a teacher, a nurse, and other high remunerating courses at colleges without mathematics. Recently, the Ministry of Higher and Tertiary Education has announced free education to those students enrolled in Mathematics, Physics, Chemistry and Biology under a Model code named Science, Technology, Engineering, and Mathematics (STEM). Still, the numbers are not growing. This has given this study a place to argue that there should be another strategy that need to be explored further that motivates learners to love mathematics, and this is the utilization of traditional games familiar to learners into which mathematical operations are embedded and teaching and learning process become just an extension of their usual life activities.

2. Statement of the Problem

The growing failure rate in mathematics, necessitated by learners' drop outs, hating mathematics and low enrolment in mathematics by learners both at primary and secondary school levels is a cause of concern to parents, learners and the educators. This scenario has negatively impacted on economic and technological development of many nations in developing nations.

3. Research Questions

- Which traditional games teach mathematical operations?
- To what extent do the traditional games helpful in the teaching and learning of mathematical concepts?
- Which mathematical myths demotivate learners from pursuing maths as a subject at school?

4. Objectives of the Study

- To identify traditional games which teach the mathematical operations.
- To explain the extent to which traditional games teach the basic math's operations.
- To explain the mathematical myths which demotivate learners in schools.

5. Significance of the Study

The study provides the mathematics teachers with new trends in the teaching of maths operations using the funniest creative approach that harness the power of traditional games found in their communities, therefore increasing the 'love of wisdom' through honouring indigenous knowledge systems. Furthermore, the research findings shall be made available to school libraries and college libraries and some mathematical coaching clinics shall be put in place in some districts by the researchers. The study will assist to disqualify the often perceived mathematical myths and contribute to an increased enrolment and pass rate in mathematics.

6. Assumptions

The researcher assumed that:

- There is lack of creativeness on the part of teachers when teaching maths in schools.
- Once learning and teaching process is made funny and related to everyday life activities, learners will not hate it.
- There is untapped value in the traditional games as approaches to teaching and learning of mathematical concepts.

7. Definition of Terms

Contextualization: is the teaching of basic skills in the common understanding of the learner's life-style.
Mathematization: is the act of expressing real world contexts mathematically.
Traditional games: these are the indigenous play activities familiar to learners which this study envisages to have mathematical values.
Interactive teaching and learning: a process in which learners have concrete familiarization with the learning environment, the learner being at the center of learning manipulating objects of mathematical value.
Pedagogics: the process of learning and teaching that is conducive, learning processes in a school environment.
Myths: these are testified legendary beliefs learners attach to mathematics as difficult subject in schools curriculum.

8. Summary

The continuous hate and fear of mathematics in schools has been a cause of an outcry by parents, teachers and learners themselves and this has motivated this study to come up with formidable ways of harnessing the power of traditional games into the teaching and learning of four basic mathematical operations at primary school level. The researchers have theorized that contextualizing mathematical teaching and learning process is an approach worth trying to improve students' performance.

9. Review of Related Literature

9.1 Introduction

This chapter covers some African traditional games in which mathematical skills and concepts are embedded and how those games are played so that teachers are learners can employ as they contextualize mathematics in their lessons. Contextualizing the teaching of mathematics is believed to be the most effective approach that makes learners love mathematics.

9.2 Traditional games of mathematical value

For neo-Vygotskians, play is considered to be a 'leading activity'; play provides an important context for learning and development, (Leontiev, 1981, Oerter, 1993). From this observation, it is imperative to identify those games that have mathematical calculations which can be adopted by teachers of mathematics in schools especially primary teachers.

The term "traditional game" is derived from the two words "tradition" and "game", (Ituh, 1999, in Amusa et al 1999:59). Furthermore, Benderly, (1977), posits that traditions are the conventions, norms and attitudes that have been perpetuated in any community, and the word "game", according to Leornard, 1984) refers to a play that is structured on the basis of rules, formal or informal, by which the players must abide. This means traditional games, therefore are acceptable indigenous plays that are handed down from one generation to another. Once they are community bound, learners can fully appreciate those games and it is advantageous to the teacher to introduce maths concepts relating them to how those games are played. Taking life-style activities to the classroom situation becomes an extension of the common life and there is no break between the learning of new concepts in maths and the common life experiences of the learner.

9.3 Contextualizing Mathematics through Traditional Games

The modern interactive teaching and learning activists like Janassen (2009), advocate the use of computers gadgets as mind tools that advance child interactivity with a learning environment, but common argument is that how many schools in under-developed nations like Zimbabwe and its remote rural schools have access to computers, let alone electricity availability. Therefore, this calls for the embracing of low cost innovations like the use of traditional games in solving mathematical pass-rate dilemma. Traditional games common in several African communities that have been played by people of young ages as past time games include these:

a. Nhodo game

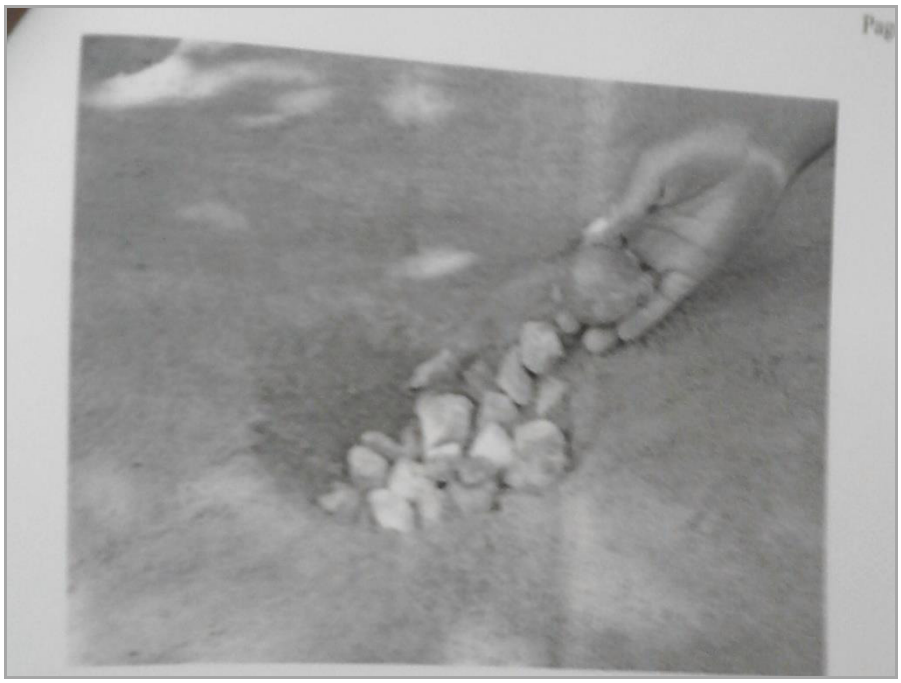

Figure 1

This game involves digging a small hole in the ground and then placing a number of small stones in it. The game is played by two or more children. Each player tries to scoop all the stones out of the hole and then scooping them back into the hole one by one, then in twos, then in threes and so on until eventually one scopes them all back into the hole. This is done by first throwing one stone (called *mudodo*) into the air while simultaneously scoping out all the stones out of the hole and catching it before it falls to the ground. The *mudodo* is then thrown again while scooping back the stones into the hole as described above and catching the *mudodo* before it falls to the ground.

a. Tsoro game, NsaIsong

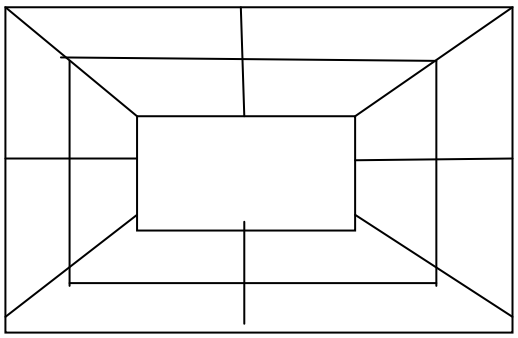

Figure 2

This is a game played by two people, each with 12 children (tokens). It is often drawn on the ground but sometimes is played as a board game. Each player aims at having 3 of his tokens in the same line, either horizontally, vertically or diagonally, while at the same time impeding the other player from coming up with this pattern.

c. Madhadha ari pamutsetse*:* this is a song game in which a player imagine having ten ducks on a line, starting either by descending order i.e. subtraction starting with numbers figure 1 until the player comes to zero, and one can be assigned to start in ascending order using figure 1 until ten ducks.

d. Pada

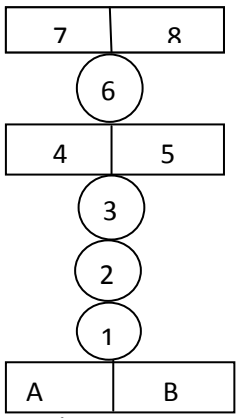

Figure 3

The playing field consists of a combination of rectangles and circles. The player positions him/herself in the first two rectangles with one leg in rectangle A and the other in rectangle B. The game is played by throwing a pebble into circle 1 through to rectangle 8. Each time the player hops past the pebble balancing on one leg and only lands on two legs on reaching two adjacent rectangles and picks the pebble on the

return journey. Thus, the game is played from "*mamu* 1" through to "*mamu*8". After going through all the stages the player once more positions himself with one leg in rectangle A and the other in rectangle B, but this time facing the opposite side and throws the pebble backwards so that it lands in one of the circles or rectangles and becomes what is called "*chikoko*". Thus, the player has the privilege to stand using both legs when he gets to the "*chikoko*".

e. Rakaraka - free start

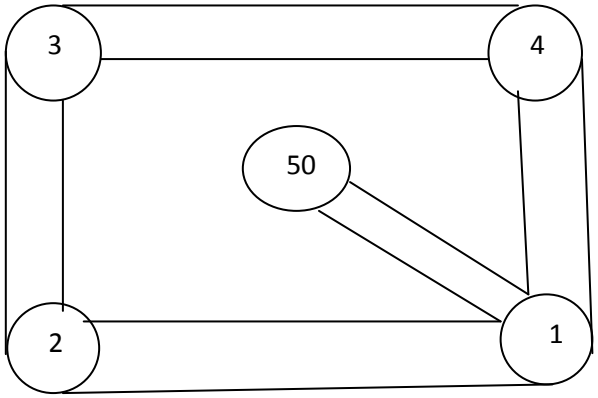

Figure 4

The game is played using a ball and is played by many players who are divided into two groups. The game begins with one group stationed in the circle at the center while two members of the other group would stand facing each other on either side of the longest straight edges of the playing field throwing a ball to each other with the intention of hitting their opponents with tithe players who are inside would run to circle 1 and then to circle 2, 3, 4 and back to 1 counting from 1 to 49 as they do so until they come back to the starting point when they get at number 50. Those who are hit by the ball would pull out of the game and would only rejoin the others if one of their members successfully comes back to the starting point. If they are all eliminated it would be the turn of the other group.

f. Sikuza

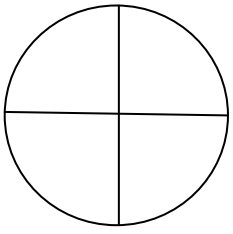

Figure 5

This game is played by one to four people. This game is played by one player jumping into the quarters of the pie-chart. Depending with grade level, watchers can chart out words in the topic of fractions, like 1quarter! , 2 quarters!, 3 quarters!, whole circle!.

g. Bangi-ngiria-ngiria

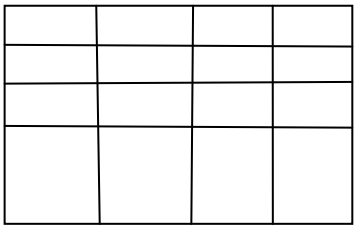

Figure 6

The game is played by moving step by step from the first box in the first row through to the last box in that row before stepping forward to the next box in the next row repeating the same process as before. Enough care should be taken to avoid stepping on the lines drawn on the ground as this would mean losing the game.

h. Hwishu

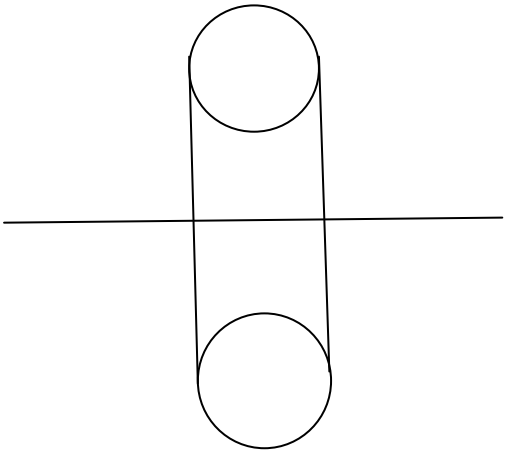

Figure 8

The game is played by many players who are divided into two groups each stationed in either of the two circles. One group is said to be the "serving" group while the other is the "receiving" group. The serving group would roll a ball towards the receiving group. A member of this group kicks the ball as far away as possible. They would then run from their side to the servers circle crossing a line and back to their circle and would continue back and forth counting the number of times they reach the servers circle before the ball is brought back into play. In this game, the players will set their "game

point" (the number which they wish to reach). Once that number has been reached by the receivers, it will be a game point.

Researchers of this study have a glowing interest in explaining how these traditional games can be used in the teaching of mathematical concepts. According to Berns, (2001), contextual teaching and learning is a conception of teaching and learning that helps teachers relate subject matter to real world situations, and motivates students to make connections between knowledge and its applications to lives of family members, citizens and workers. Traditional games are a good example of approaches teachers could harness these games' power to motivate children to learn mathematical concepts in a funny way.Thus, students must be equipped with knowledge and skills that enable them to transform the society in which they live. Contextualization can be conceived as a learner-centered teaching approach. In this regard, the instructor focuses on what students are learning, how they are learning and they use the learning, (Weimer, 2002). Multz, (2010) concurs by viewing contextualization as a form of "deeper learning" that comes about through linking ideas and concepts across courses.

Perin (2011), asserts that in anyone programme, contextualization of basic skills instruction contains one or more of the following components: interdisciplinary learning, use of students' informal, out-of-school knowledge, active-student-centered learning, student collaboration, use of explicit literacy strategies, authentic, everyday life situations. The African traditional games are undoubtedly harnessing all these components necessary to learners of mathematics in schools.

Furthermore, Perin, (2011) brings in another observation that there are two forms of contextualization teaching: contextualized instruction and integrated-basic skills instruction. Contextualized instruction would be employed by mathematics teachers when exploiting the real life experiences, like games, to teach mathematical concepts, while integrated instruction would be employed by discipline-area instructors in academic, career and technical areas. However, the term 'contextualization' is used to refer collectively to the two forms of instruction. On the other hand, integrated basic skills instruction is the incorporation of reading, writing, or maths instruction into the teaching of any content, (Perin, 2011). The incorporation of maths skills and other subject language skills is a common phenomenon when children interact during traditional games in their cultures.

10. Mathematical Myths in schools

Teachers, students, parents and communities have fear of Mathematics, largely because of some myths associated with the subject. According to Nyikahadzoyi (2012) some of the myths in Mathematics include:

- The belief that Maths is simply a collection of facts and procedures and doing mathematics is simply recalling the facts and performing memorized procedures'
- Mathematics is perceived to be increasingly mysterious, full of symbols and no words.
- Mathematics is hard and requires a good memory
- One is born with mathematical talent or not. There is no room for creativity.

Furthermore, researchers like Erickan, MacCreith and Laponte, (2010), established factors that are associated with mathematics teaching and learning process. They pointed out that people believe that mathematics is a hard subject not for women but men, this is echoed by Tobias,(2013) and Panaoura and Philippour (2016).

A list of myths was identified by www.uaf Development Education:

- Men are better in maths than women. (yet researches have failed to show any difference)
- Maths requires logic not intuition- (but intuition is the cornerstone of doing maths and solving problems. Mathematicians always think intuitively first).
- Maths is not creative-(creativity is central to maths as it is to art, literature or music)
- It is bad to count on your fingers
- It is always important to get the answer exactly right-(yet the ability to get approximate answers is often more important than getting exact answers.
- Some people have a 'maths mind' and some don't - (belief in myths about how maths is done leads to a complete lack of self-confidence.
- There is a magic key to doing maths. – (there is no formula, rule or general guideline which will suddenly unlock the mysteries of maths. If there is a key to doing maths, it is in overcoming anxiety about the subject and in using the same skills you use to do everything else).
- Maths requires a good memory - (knowing maths means that the concepts make sense to you and rules and formulae seem natural. This kind of knowledge cannot be gained through rote memorizing).

A more similar viewpoint was given by the MathPlus Academy, (2016) as five most harmful maths myths:

- Some people have the 'math gene' and others don't. – (there is no conclusive research that shows any genetic predisposition for excelling at maths)
- Boys are better at Maths than girls
- Mathematicians do problems quickly and never make mistakes-(what distinguishes a mathematician is the ability to identify patterns, willingness to try new ideas and their desire to persevere through failures).
- Speed is a measure of ability in mathematics - (yet it is through experience and practice)
- A great memory is the key to excelling at maths

Fortunately these are mythologies which may also require further researches, therefore, one cannot be penalized of believing in them since authors have pointed out that they are not proven as yet, but can militate against learning of mathematics in schools. Better methods of dispelling such myths is to bring in some creative ways of teaching and learning maths, like harnessing the motivational power of traditional games.

11. Research Methodology

11.1 Introduction

The researchers undertook a phenomenological perspective when generating data from the rich informants in the teaching and learning field. This study has adopted a qualitative approach in soliciting data, hence a case study was the design deemed most appropriate.

11.2 Research Paradigm

The study focused on rich informants' personal experiences in the teaching of mathematics, a subject that most learners have found to be most difficult as depicted by its lowest pass rates both at junior and senior educational levels. The personal experiences involved perceptions, myths, beliefs, attitudes and arguments of learners, teachers and parents on performance and teaching of mathematics as a science subject. Therefore, the ideal research paradigm adopted to solicit these experiences was the qualitative. The underlying rationale for choosing the qualitative route was that the nature of the study questions calls for inductive reasoning where specific participants were observed and interviewed in their natural settings and generalization was made, (Welman, Kruger and Michell, 2005)

11.3 Research Design

This study adopted case study as the deemed design for the reason that, a case study allowed the researchers to have an in-depth study of one set of characters who were teachers, children, and parents in a given natural setting whose perceptions, attitudes and code of contact were governed by the same culture.

11.4 Population and Sampling

Teachers, children and parents made up the population that the study focused when soliciting relevant data. The study had unlimited sample size as the data collection process was governed only by when the rich information reached saturation and satisfied the researchers as enough and authentic to answer the research questions. Therefore, the sample size ended up to fifty (50) participants.

Purposive sampling was used in this study (Oliver, 2006, in Kaputa, 2011) to identify the three sectors concerned in the teaching and learning of the child. This technique was selected because it enabled the researchers to identify information-rich participants in schools. Confidentiality and anonymity of the participants was assured, yet it was motivating to the participants as they found themselves as experts and creative people in the teaching and learning of mathematics in schools. However, participation was voluntary and the decision to take part was on the basis of informed consent, especially the children.

12. Discussion of Findings

12.1 Importance of Traditional Games

As postulated by Mosimege, (2000), this study has also found out that indigenous games are usually viewed from the narrow perspective of play, enjoyment and recreation, yet there is more to them than just these three aesthetic aspects. It emerged that children are mostly likely to be creative when they use their ideas and usual experiences; and make new connections through play.

Observations showed that only infant grades usually use contextualization (inform of traditional games like song-game *Madhadha ari pamutsetse (Ducks in a line)* when teaching subtraction concept. Environment-based pictures are frequently used in elementary classes, but junior and senior grades abandon this approach and prefer formulae and patterns. This scenario alienates learners from their natural concepts and that leads to abstract thinking and to demotivation.

12.2 Tsoro

A look at the playing field when children were introduced to this game during lessons reveals that there are various shapes of varying sizes and hence the concept of shapes, similarity, measurement, and area and number patterns can be addressed. The concepts of ratio and proportion can also be addressed when children compare the number of games won by player A as compared to those won by player B. Use of this game inculcates such mathematical skills as reasoning, interpretation, calculations and identification. Children conversant with this traditional game at junior and senior level could easily play the game of 'chess', interviews of teachers revealed so.

12.3 Pada

It was consolidated by interviews and observations that there are some mathematical ideas embedded in the game of *pada* and it is enjoyable for children to learn concepts of shapes and their properties e.g rectangles and circles including the idea of geometric space. The motivation came when each of the players wished to be the first to play as he/she would have more chances of winning '*chikokoko*' as all the 8 spaces (Fig.3) would be available to him/her, hence the concept of probability can be built from the game. That is, if 1 space has been won as '*chikokoko*' the probability of the next player winning would be 7/8 assuming that each player has an equal chance of winning. Teachers' response to the value of this game was 100% in agreement, and those who tested it recommended it as another simpler way to teach probability, one of the most difficult mathematical concepts. It even emerged that the game of *'chabuta'* (dices) is common game among learners and is relevant approach to teaching and learning probability concepts.

Secondary grades introduced to the game of *Pada*at one of the schools went on to use it when teaching and learning the 'inverse variation'. They said "the more the number of players the less the number of spaces (*chikokoko*) to be won.

12.4 Nhodo

This game was seen to be useful in the teaching and learning of numeracy. Each player learns to count from 1 to higher numbers in an orderly manner. The concepts of factors and multiples can also be learnt through playing *nhodo*. This game was seen to be more common among school children and is suitable to primary children. The game also teaches accuracy, coordination and logic and calculation skills.

12.5 Bhangi-ngiria-ngiria

Creative teachers pointed out that they find the game important in teaching multiplication. For example, '*bhangi =2 boxes, ngiria=3 boxes, ngiria=4 boxes.*The first row going to the right has 4 boxes and the last column going downwards has 4 boxes, once two children move in these two directions the equation is 4x4=16, i.e. area. Any number of boxes moved by two students in those different directions, when multiplied would give area covered. That game is most suitable to grades where the concepts of area and multiplication areintroduced.

12.6 Rakaraka and Hwishu

The games*rakaraka*and *hwishu*have very little to teach in terms of mathematical skills, but invigorate mental alertness as well as counting. However, these games are good introductory games to cricket. Teachers confirm that these two games have no much attachment with mathematics therefore, teachers seldom employ them.

13. Conclusion

From the discussions of the results, the researchers have made the following conclusions:

1. Traditional games are commonly used by infants' teachers, but junior and senior grades concentrate on abstract examples and formulae, to which most children take time to comprehend and conceptualize.
2. Children good at mathematics can demonstrate to peers easily using practical examples, e.g. probability by playing *'chabuta'* (playing cards).
3. Once skills are embedded in games, learners tend to love and appreciate mathematics as a subject.
4. Most mathematics text books emphasize formulae which are far from learners' conceptualization ability, making mathematics a boring subject.
5. There are too much myths attached to mathematics as a subject, and these have also contributed to maths phobia.
6. Mathematical games, in form of traditional plays, use indigenous languages which enable quick understanding of the mathematical concepts and skills.

14. Recommendations

This study makes these recommendations:

1. Senior and junior classes should employ traditional games common in a particular community when teaching and learning mathematical concepts for easy understanding.
2. Teachers must allow peer groups to exist and teach other children using their local languages.
3. Mathematics text books should be revised to accommodate traditional games from ECD to higher grades.
4. Schools and communities should start to campaign against mathematical myths attributed to this subject by most societies.
5. The teacher should make sure the game matches the mathematical objective.
6. The teacher should keep game completion time short.
7. The children should be given the games as homework.

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