Investigating the Relevance of Preparatory Mathematics in Three Selected Kindergartens in the Zambezi Region of Namibia

Ilukena Mbonabi Alex
Musiba Makando Autilliah
Simasiku Muyumbano Bosman
University of Namibia
**Corresponding author: milukena@unam.na*

ABSTRACT

This paper is based on a qualitative case study which investigated the relevance of preparatory mathematics in three selected kindergartens in the Zambezi Region of Namibia. A snowball sampling procedure was used, were each successive participant was named by a preceding individual. Eighty – three (83) kindergartens children aged 5 – 6 years old and four (4) kindergarten teachers took part in the study. The data was collected by means of two methods namely documents analysis and semi – structured interviews which provided a degree of cross checking of claims. The main findings of the study were that the preparatory mathematics is unique, interesting and relevant to the kindergartens and further has basic elements of mathematics that is appropriately connects to the mathematics taught at junior primary, senior primary, junior and senior secondary and the tertiary institutions.

Keywords: Kindergarten, Preparatory Mathematics, Coloring or Shading, Rectangle, Square, Circle & Relax time

1. INTRODUCTION

The name kindergarten was coined by Friedrich Froebel in 1840 in German based on the idea of playing, singing, practical activities such as drawing, and social interaction as part of the transition from home to school. He shared Rousseau's vision of the innocence of childhood and, with Pestalozzi, he believed in the importance of connecting learning to real – life experiences (Prochner & Kabiru, 2008). A key element of the kindergarten was that education must follow a child's lead. Furthermore Froebel believed those children's minds to be fully formed at birth and capable of reason. Therefore a teacher's role is to guide and bring a child's inner reason to full flower by introducing materials known as "gifts" and activities, called "occupations". These of these materials were easily assimilated into infant school practice; kindergartens use these materials as "building blocks" to develop work skills, and manual dexterity, and perseverance.

In the former South – West Africa (Namibia) the German colonial administration exported kindergarten in the year prior to World War 1. These kindergartens were only for the children of German colonists, but, in some instance, were for "Coloured" children, until the latter were barred in about 1905 (Smith, 1998 as cited in Prochner & Kabiru, 2008). At independence in 1990 the Namibian government adopted a policy that every primary school should have a wing of kindergarten however this did not materialise well due to the creation of different ministries that were tasked with the responsibility of the foreseen running of the three early childhood programme that's the infant school, kindergarten and the nursery school.

The first two prepare children for schooling with focus on academics and work habits (in the future), while the nursery school serves as a bridge to school with focus on the home and the child's emotional life (in the past and present). The focus of the study was to understand the preparatory mathematics taught at kindergarten level and its relationship to the pre-school, primary school and ultimately to the secondary school via tertiary institution. The study also unpacked the numeracy curricular at ENVIRONMENT, WATER AND PLANT kindergartens respectively.

2. BACKGROUND OF THE RESEARCH

The term kindergarten is used in many countries to describe a variety of educational institutions for children ranging from two to seven years of age, based on a variety of teaching methods and reasons as stated above. This research was prompted by the following reasons, namely:

- The mushrooming of the kindergartens in the Zambezi Region as recognized by the Ministry of Gender and Child welfare; and the Ministry of Education.
- Mathematics being made compulsory throughout schooling despite high failure rate in Namibian schools.
- Mathematics for All matched with Education for All.
- The relevance of preparatory mathematics at kindergarten, primary, secondary and tertiary level. And
- The exclusion of the Preparatory Mathematics Teachers in teaching and learning professional communities in mathematics.

3. THEORETICAL FRAMEWORK

This research is based on Bruner's Theory of learning which mentions of the three modes of representation, namely: Enactive (action-based), Iconic (image-based) and

symbolic (language-based). Firstly, the Enactive (action-based) mode of representation involves a tangible hand – on – method of learning. Learning begins with an action – touching, feeling and manipulating (Brahier, 2009, p. 25; Ferron, 1989). Manipulatives in mathematics are concrete objects with which the action is performed. For *e*xample manipulatives such as algebra tiles, paper, coins, counters, …., or anything tangible. Secondly, the Iconic (image – based) or pictorial mode of representation involves image or other visual representations of the concrete situation. The kindergarten learners simply draw images of the objects on worksheets or picture/ images in their heads/minds. This can also be done through the use of shapes, diagrams and graphs. Thirdly, there is the Symbolic (Language – based) mode of representation which may be referred as being the abstract stage or last stage. This mode of representation is stored primarily as words, mathematical symbols, or in other symbol systems.

Bruner's theory also allows teachers to engage all learners in the learning process regardless of their cognitive level or age. They construct knowledge and skills through discovery learning referred to as constructivism. The development and use of an academic language is crucial for learning the concept successfully. It takes place in the transition from the iconic stage to the abstract, language – based, symbolic stage (Mcleod, 2008; Culatta, 2012). It should also be noted that Bruner's theory is useful in teaching mathematics which is primarily conceptual, as it begins with a concrete representation and progresses to a more abstract representation.

4. LITERATURE REVIEW

Regardless of where children grow up, they develop basic mathematical concepts and strategies to solve a variety of mathematical problems before even starting formal schooling (Allardice & Ginsburg, 1993; Ferron, 1989 as cited in Ilukena, 2011). This type of mathematics referred above is embedded in ethno-mathematics (Ilukena, Ausiku & Luwango, 2013) which is important and relevant prior knowledge for school mathematics. Recent research has shown that many learners cannot see the connection between the mathematics they do at school and the mathematics that they do in other places such as at the market, kitchen, or in the field (Portman & Richardson, 1997, #Hara – Gaes, 2005 cited in Makari & Kasanda, 2013; Gervasius & Kasanda, 2006; Carraher, Schliemann & Carraher, 1988, Onwu, 1992, in Ilukena, 2008).

An elementary mathematics textbook should provide visual learning (media) aids, sources of ideas and approaches to curricular topics. However, it is the teacher who creates conducive learning and uses the resources wisely to promote real mathematics learning (Smith, 2013). Ilukena, (2011) suggested that the Namibia curriculum should have a strong spiral link between preparatory mathematics at kindergarten, Pre-Primary and mathematics from grades 1 to grade 12. In the past the foundations were not properly laid in each grade and built up across educational levels (Namibia, Ministry of

Basic Education, Sport & Culture, 2004; Clegg, 2007; Namibia. Mathematics and Science Teachers Extension Programme (MASTEP); Namibia. (MEC), 1999 cited in Ilukena, 2008; Ilukena, Ausiku and Luwango, 2013) showing a concern among sections of the Namibian public over the performance of learners in mathematics.

Recently the founding President of the Republic of Namibia Dr. S. Nujoma said the only way poverty and hunger can be fought is by ensuring that children are given education. "We must now ensure that our children go to kindergarten, primary and secondary school up to university (Njovu, 2014). Unless the foundation is strongly secured well using the van Hiele Model (Dina van Hiele – Geldof and Pierre Marie van Hiele) -- the five levels of developmental thinking and reasoning in geometry our children will find difficulties with high school geometry and other mathematics if their early learning is weaker in the five development stages: visualization, analysis, informal deduction, deduction and rigor as research by (Crowley, 1987) reveals. This concurs with Hannibal (1999) who found that children aged 3 to 6 are reluctant to give up their notions about what constitutes a particular shape. It should be noted that research has shown that it is only primary teachers with well-equipped mathematics content knowledge who are able to explain mathematical concepts to their learners; otherwise these teachers will struggle to teach the mathematics confidently (Brainer, Cruickshank & Metcalf, 1995; Kasanda, 2005). Unless the foundation of the children is secured, it will be extremely difficult to build their mathematical and scientific success at lower grades via primary to secondary phase.

5. RESEARCH METHODOLOGY

5.1 Research Design

This was a qualitative case study design, so the design was closely kept to qualitative research practice.

5.2 Population and Sample

The population of this study consisted of eighty – three (83) kindergartens aged 5 – 6 years old and four (4) kindergarten teachers took part in the study. All four preparatory mathematics teachers, three females and one male were interviewed.

5.3 Research instrument

A semi – structured interview was used to collect data from the participants. Interview questions were based on the historical background of the kindergarten, current enrollment, relevance of teaching preparatory mathematics at kindergarten, qualifications of participants, and type of mathematics taught, to mention but few. We

also analyzed some of the learners' worksheets and kindergarten preparatory mathematics syllabus.

6. RESULTS AND DISCUSSIONS

The findings reveal the following;

6.1 Historical Background of each Kindergarten

(a) Environment Kindergarten

It was established immediately after independence on the 1st July 1993, with 4 female teachers, a gardener and one security guard. It was the initiative of the school principal, Ms E with the support from the board members. The table below shows the 2014 enrollment statistics at Environment Kindergarten.

Age Group	Boys	Girls	Total
0 – 2 Baby Class	5	4	9
3 – 4	8	4	12
5 – 6	8	8	16
Total	21	16	37

(b) Plant Kindergarten

It opened on the 9th of September 2009 with one kid but the number increased by October 2009, to 5 Kids. The table below shows the 2014 enrollment statistics at Plant Kindergarten.

Age Group	Boys	Girls	Total
3 – 4	20	35	55
5 – 6	20	15	35
Total	40	50	90

(c) Water Kindergarten

It began in the year 2008 – 2009 by the church. It is the initiative of the Education secretary who was supported by the church board members and the entire church. Fundraising campaigns were held to financially support the Kindergarten. The table below shows the 2014 enrollment statistics at Water Kindergarten.

Age Group	Boys	Girls	Total
0 – 3 Baby Class	15	15	30
3 – 4	32	30	62
5 – 6	14	18	32
Total	61	63	124

6.2 Qualification of the Kindergarten Teachers

This research revealed that most of the kindergarten teachers have a Grade 10 certificate and they are upgrading their academic qualification through institutions such as NAMCOL, Tutaleni (School) in Northern Namibia and Ministry of Gender Equality and Child Welfare, in course of Early Childhood Development (ECD).

6.3 The different subjects taught at three Kindergartens

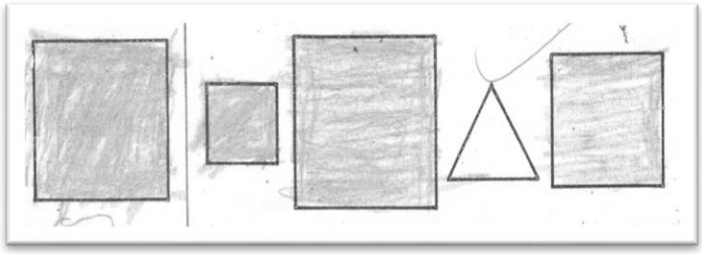
The following subjects are taught at the three Kindergartens in the Zambezi Region namely: Religious and Moral Education, Preparatory Mathematics (in focus), Physical Education, Language Development, Environment learning, Arts and Story Time. This research further revealed that there is a special time on the time table referred to as "Rest and Relax".

6.4 The type of mathematics taught at Kindergartens

Firstly the type of mathematics taught at the three kindergartens in the Zambezi Region is preparatory mathematics (Often called Numeracy). This type of mathematics is built around important life themes, for example

- Theme 1: My body; Theme 2: My family; Theme 3: My home; Theme 4: My school; Theme 5: My community; Theme 6: Animals; Theme 7: Water & Theme 8: Plants
- Every theme has a number emphasis: Theme 1 of my Body emphasizes the teaching of the numeral 1. The word numeral is first met at the kindergarten.

Secondly, from coloring to advanced mathematics (Number Pattern) this research revealed that the topic on identifying and continuing patterns of big shapes and number sequence is one of the topics taught at the kindergarten. Children count numbers forward or backward from 1, 2, 3, 4, …, 8, 9, 10 in association with objects at times. The activity *which asked to color the ones that are the same* below reveals some number pattern from coloring by a 5 year old girl called LINA at ENIVORNMENTAL kindergarten.



- Counting numbers: 1, 2, 3, 4.

➢ 2 – 1 = 1, 3 – 2 = 1, 4 – 3 = 1 Arithmetic Progression (AP) This is level 1
General formula = an + b

➢ a + b = 1

➢ 2a + b = 2 Simultaneous equation, Laws of Addition/Subtraction/Multiplication and division.

➢ Eliminate b: a = 1 then b = 1 – 1 = 0

Substitute a = 1 and b = 0 in the general formula then formula ***(1) n + 0 results*** in *n* as a formula.

- Odd numbers: 1, 3, 5, 7, 9

➢ 3 – 1 = 2, 5 – 3 = 2, 9 – 7 = 2 Arithmetic Progression (AP)

Type of the numbers (odd number) ***General formula = an + b***

➢ a + b = 1

➢ 2a + b = 3 Simultaneous equation, Laws of Addition/Subtraction/Multiplication and division.

➢ Eliminate b: a = 2 then b = 1 – 2 = -1

➢ Substitute a = 2 and b = - 1 in the general formula then formula is 2n – 1.

The findings indicate that by coloring various figures inside a child unconsciously creates a representation of area, perimeter and radius while visualization of shapes creates a pattern representation of functions and classification of shapes by sorting, recognizing patterns, seeing shapes as sets of objects and numerals or numbers attached to these objects or shapes. Furthermore the activities on identifying and continuing patterns have connections to advanced mathematics topics such as arithmetic progression and generalization involving algebra. The calculations show the connection between simple patterns to complicated general formulae of the patterns on counting and odd numbers as explained above.

This research revealed that a mathematical thinking skill is one of the skills taught at the three kindergartens. For a child to color correctly and accurately he or she needs Dienes (1967) four levels of mathematics thinking which relate to Bruner's theory which include generalization, representation, symbolization & formalization. These levels of thinking can further be compared to George Polya's step of thought (1957) of understanding the problem, devise the plan, carry out the plan and reflect (look) back.

This research further revealed that the concepts of “slides”, “flips”, turn” and “rotates” are some of the geometry concepts used in the kindergarten. These are concepts used in the study of motion geometry which are clarified by providing examples and non – examples. It was further revealed that the use of block construction as a teaching media needs to be supplemented by geoboards or graph papers.

We also found out that kindergarten children and their teachers could not see the connection of tracing on the dotted lines of a square, rectangle, circle or triangle to advanced mathematics involving the perimeter, area, binomial theory, formula, distributive property, 2D and 3D. We therefore suggest that kindergarten teachers should bring in the aspect of the cultural artifacts such as: *Moono (Lukuko)* – (Pyramid shape or Cone), *Chandi* (Rectangle shape), *Kapongoleni* (Oval shape), *Chipaipai* – Triangle, *Kapali [Kahambwe]* (Clay pot), *Isasa lyamakama kapa lyempe* (Traditional mat), *Mashamba*, *Chiziba*, traditional attires, …. “(Ba Induna Jeremia Sichombe; Agnes Namasiku Kamwi (Bana Mukanwa) & Elizabeth Iuze Sichombe (Bana Liyali), personal communication, July 20, 2005). These examples will consolidate the teaching of shapes from home to the school arena.

Thirdly, we also found out that children learn preparatory mathematics effectively through play which is referred as nature’s method. The method of learning by doing and discovery (Piaget in Ferron, 1989, Smith, 2013) enhances the effectiveness of play. It is argued that a child can’t even think without using his/her hands – on activities, Hand – Mind (Maria Montessori in Ferron, 1989 & Smith, 2013). This method of learning referred to as personal experiences, by Rousseau [1712 - 1778) and Pestalozzi (1746 – 1827) in Ferron (1989) argue that as practicing teachers need to love, understand the children and communicate effectively with them, especially when working on the puzzle of fitting shapes, tessellation, serration, problem solving or any other activity.

6.5 The language of teaching and learning (TL) of the preparatory mathematics

The medium of instruction at all three kindergarten is English; however two languages are used that’s English and dominant language of the region (Silozi). It should be noted that Silozi in the Zambezi region is not the mother tongue; but a lingua franca originating from Zambia. It is adopted as a language of teaching and learning in Namibian schools particularly Zambezi region as a unifier and to support the notion that “if children use their own language (in this case Silozi), they can express their own ideas; they can be creative. But if children have to learn in a new language, they are put into a kind of prison. They cannot tell the teacher what they think … you limit their creativity and put a ceiling on what they can do” (Macdonald & Burroughs, 1991 .p. 25). Our findings are that although children are taught in English, teacher’s switch from one language to another in the midst of their conversations, in most cases as Richard Skiba

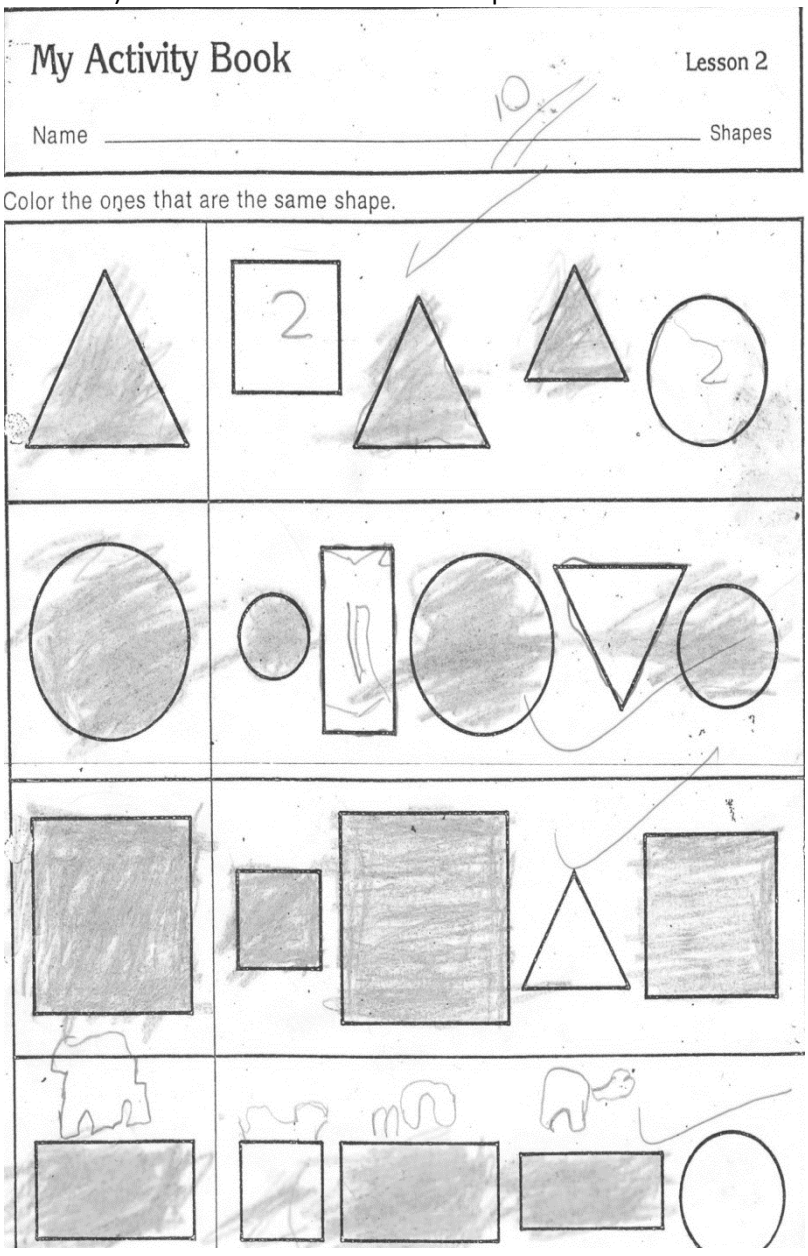
noted, is a result of inability to express oneself in the language in use, and thus switches to the other to compensate for the deficiency. This often happens mostly at the beginning of each academic year when new children enroll to accommodate all children and when children can crackdown the code, the language of teaching and learning (English) is used throughout.

6.6 Assessment activities on numeracy

This research revealed that at the three kindergartens both formative and summative assessments are used as part of assessment. Formative assessment enables the teachers to find out where their children are at the start of the teaching or learning process and enables the teacher to find out where children are at during the teaching and learning process, this promotes and support learning. We further found out that assessment occurs throughout the year on daily basis. Teachers use a variety of assessment strategies in which tests and examination are but one. The different strategies enable teachers to gather evidence of learning in ways other than examinations. In support of the claims, assessment below is the work done by a 5 year old girl called LINA at ENIVORNMENTAL kindergarten in 2014.

i) Class Activity

ii) Marked Examination Scripts



It also revealed to us that as part of summative assessment, children are given achievement certificates during graduation ceremonies held at the end of each academic year.

6.7 Materials for preparatory mathematics

The following documents are useful resources for preparing the teaching of the preparatory mathematics namely:

- Teacher's manual for the pre-and-lower Primary Education.
- Teaching and learning aids (Media) mostly and commonly used are, the numeral tracing chart, Addition chart, Worksheets e.g the numeral worksheet, shape classification worksheet, Concrete aids such as cubes, cuboids, bottles, seeds, drawing and coloring pencils, improvised material to mention but few.

It also revealed that although they do not prepare together, they do consultations with one another on how to teaching number activities. In this way their challenges are addressed amicably, on where to get assistance in terms of numeracy materials.

6.8 Benefits of teaching preparatory mathematics at the kindergarten

This research has found the following benefits of teaching preparatory mathematics at the three selected kindergartens:

- The ability to communicate in the language of numeracy and ability to apply what they have learnt at home e.g. able to identify and bring the right amount of something in the class and even at home when parents ask them to bring one cup, etc.; able to identify colors and appreciate their importance in classification and lastly able to identify shapes of a certain color
- It also forms a strong foundation for lower primary, primary, secondary and tertiary education
- It was mentioned that some of learners who attended Environment kindergarten have successful completed courses in engineering, technology

7. CONCLUSION

This study found impressive findings on preparatory mathematics curricular of the kindergarten in the Zambezi region. We can therefore argue that preparatory mathematics is quite interesting and relevant to the kindergartens. It further has basic elements of mathematics that appropriately connects to the mathematics taught at junior primary, senior primary, junior and senior secondary. We therefore urge parents, mathematics teachers and lecturers to consolidate the foundation laid by kindergarten teachers. It is important that if this happens then we can engage ourselves in the discussion of preparatory mathematics offered by kindergartens through the Ministry of Gender Equality and Child Welfare, via the mathematics offered by Ministry of Education, and institution of higher learning by seeing the connectivity of these mathematical subjects.

One of our several recommendations is that these research findings need to been present to the Ministry of Gender Equality and Child Welfare in particular the kindergarten teachers, principals and kindergarten children. We therefore recommend

the followings:

- All stakeholders should support kindergartens to strengthen the numeracy curriculum.
- Workshops on the numeracy curriculum should be held in schools as per circuit in the region.
- We also recommend that numeracy curriculum should be studied not only kindergarten teachers but also teachers at primary, secondary and tertiary institutions. [network theory enriched with relational understanding of the numeracy curriculum]
- We recommend that a committee be set up to facilitate consultation process on the issues of numeracy or preparatory mathematics. They should link the two ministries that of Gender and MoE terms of mathematics.
- We recommend syllabi be designed not only the teacher's manual on numeracy. People with expertise in mathematics should be involved.
- We recommend the establishment/revival of Professional Learning Communities in mathematics in schools to include Kindergarten teachers.
- We urge Institutions of higher learning to start offering a degree at NQF level 7 in numeracy but also a certificate and a diploma.

REFERENCES

Brahier, D. J. (2009). *Teaching Secondary and Middle School Mathematics*. Pearson Education, Inc.

Brainer, L. D., Cruickshank, R. D. & Metcalf, K. K. (1995). *The act of teaching.* NewYork: McGraw-Hill.

Culatta, R. (2012). Constructivist Theory (Jerome Bruner). *Instructional Design.* Retrieved January 20, 2012, from http://www.instructionaldesign.org/theories/constructivist.html

Ferron, O. M. (1989). *Senior primary mathematic didactics. Butterworths :Durban*.

Ilukena, A. M. (2011). *Importance of mathematics and its impact on vision 2030.* Retrieved June 21, 2011, from http://www.newera.com.na/article.php?articleid=3927&title=importance%20...

Ilukena, A. M. (2008). *A Needs Analysis for the Implementation of a Complementary Course in Mathematics Education for Teachers of Mathematics in Namibia: A Case Study of the BETD Graduates*. (Unpublished master's thesis). Rhodes University. Grahamstown, Republic of South Africa.

Kasanda, C. D. (2005). Education in Africa post colonialism and globalisation in science and mathematics education: The case of Namibia and Zambia. In M. L. Mostert & C. D. Kasanda (Eds.), *Education in Namibia: A collection of essays* (pp. 106-123). Windhoek: Namibia.

Ausiku, C., Ilukena, M. A. & Luwango, L. (2013). September). Investigating Ethnomathematics in the Kavango East and West Regions. Paper presented at Educational Annual Conference. Windhoek: Safari Hotel.

Mcleod, S. A. (2008). Bruner. *Simply Psychology.* Retrieved January 20, 2012, from http://www.simplypsychology.org/bruner.html

Macdonald, C. & Burroughs, E. (1991). *Eager to talk and learn and think:* Bilingual primary education in South Africa. Cape Town: Maskew Miller Longman.

Makari, E. K. & Kasanda, C. D. (2013). The use of contextualized teaching and learning in grade 11 and 12 mathematics classrooms in Gobabis, Namibia. *Journal for studies in humanities and social sciences, 2(1), 73 – 88*.

Njovu, A. (2014). *Nujoma salutes Zambia on jubilee.* Retrieved July 29, 2014, from http://www.namibian.com.na/indexx.php?id=15883&page_type=story_detail&category_id=1

Prochner, L. & Kabiru, M. (2008). *ECD in Africa: A historical perspective.* Retrieved March 12, 2015, from **http://www.researchconnections.org/childcare/resources/15931.**

Smith, S. S. (2013). *Early childhood mathematics* (5th ed.). United State of America: Pearson.