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ADVOCATING FOR A BALANCED MATHEMATICS INSTRUCTION AT EARLY CHILDHOOD DEVELOPMENT LEVEL (ECD) AND PRIMARY SCHOOL: REVISITING THE ROLE OF THE TEACHER.

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ABSTRACT

The arguments on how best children learn and develop have taken centre stage in education. Different views have been expressed in terms of approaches that promote child development. Approaches and philosophies by different philosophers such as Dewey and Rousseau among others have influenced educational curricula in different countries. These approaches have contributed to the development of ideas of teaching and learning that have seen a movement from the traditional approaches to teaching and learning, which were teacher-centred to child-centred approaches to teaching and learning. There have been concerns on the performance of students in Mathematics as a subject. The low performance in this subject can be attributed to many factors. Some of the factors have to do with the perception that Mathematics is a very difficult subject, resulting in students developing negative attitudes towards it. The other factors are related to how children are introduced to Mathematics at an early age. The way children are exposed to Mathematics concepts at ECD and Primary school has a bearing on how they handle Mathematics as a subject in later years. This paper focuses on how we can promote a balanced Mathematics instruction at Early Childhood Development (ECD) and Primary school levels. It examines characteristics of a balanced mathematics instruction, the ECD Mathematics curriculum in Zimbabwe, the application of the child-centred approach in the teaching of Mathematics and the theories guiding the teaching of Mathematics. The paper concludes by advocating for a teaching approach that considers the children's interests.

Key words: Balanced Mathematics instruction; Early Childhood Development; Mathematics curriculum; theories; child-centred; teacher-centred

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1. INTRODUCTION

There are a number of theories that have been used to explain effective mathematics instruction. The theories have focused on explaining pupil-centred discovery learning and teacher-centred directed learning. Apart from bearing in mind the arguments around the theories of teaching and learning an effective mathematics teacher at ECD level has to take cognisance of essential characteristics of an effective mathematics instruction. The paper focuses on the teaching and learning of mathematics at ECD level and primary school level. The paper focuses on how the teacher uses the theories in developing the following characteristics in a mathematics lesson: the introduction; the concept; guided practice; summary of the lesson and evaluation. To bring the discussion into its proper perspective, the paper examines components of the ECD curriculum in Zimbabwe. It further focuses on how Piaget's theory of cognitive development can be used to develop maths concepts from the ages of 2 to 12 years. The following key terms are defined: mathematics instruction and ECD level.

2. DEFINITION OF TERMS

Mathematics instruction: Feeney et al (2010) define mathematics instruction as a way to structure experiences to form ideas about quantitative, logical and spatial relationships between people and events, with the aim of providing pupils with the exposure to develop mathematical language and thinking. Mathematics instruction is a highly organised social activity of teaching and learning Mathematics (people.exeter.ac.uk/PE rnest/pome18/...). Mathematics instruction therefore refers to the teaching and learning that takes place through the effort of the teacher and the learner. It refers to the approaches that are used in lesson delivery.

Early Childhood Development level: Early Childhood Development as a term can be used to refer to the different stages that children go through in preparation for life. According to Wood in Musiyiwa and Muzembe (2011) early childhood development is the physical, cognitive, emotional growth and change that take place in all children aged between birth to eight years. Minnet (2008) also defines early childhood development as the growth and development of children from birth to eight years. Within the Zimbabwean context and the context of this paper, E.C.D level refers to the stage from 0 years up to 8 years. Early childhood development therefore focuses on developing within the child the physical, health, social, emotional, language and cognitive domains.

3. CHARACTERISTICS OF A BALANCED MATHEMATICS INSTRUCTION AT ECD LEVEL

One major characteristic of a balanced Mathematics lesson level is that it should have an introduction. According to Larson (2002) an effective Mathematics lesson has a distinct beginning, which is designed to access children's prior learning, at the same time helping children to focus on the objectives of the lesson. The introduction captivates the interest of the children as they prepare for the main activity of the lesson. For the introduction to be effective the teacher should start with something that is common to the children. For example if the teacher intends to develop the concept of addition in children, he/she can start with a counting song that is common to all the children.

From the introduction, the next important characteristic is the development of concepts or skills. Children at ECD are at the pre-operational stage. According to Piaget's theory of cognitive development, the pre-operational stage is between the ages of two and seven years. Children at ECD level in Zimbabwe are between three years and eight years of age. Most of them therefore fall within Piaget's pre-operational stage, with others falling within the concrete operational stage. According to Piaget's theory of cognitive development, between the ages seven and twelve, children begin to form mental pictures of objects. At this stage the selection of activities and tasks is critical. As noted by Tipps and Kennedy (2008) in order for the teacher to develop mathematical concepts, the teacher has to make use of objects that help children to develop concepts. It therefore means that children have to work with concrete objects. For example, when

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children are learning different shapes in Mathematics, they have to work with real objects that have these shapes. From the objects children are able to develop mathematical meanings and skills. It is also important to note that the development of Mathematics concepts and skills involves children learning by doing and practising. The Mathematics lesson has to be child-centred. The cognitive theorists' view of learning Mathematics is very important. They believe that the age of the child is very important in learning and that learning takes place in stages. This is also important for the teacher as he/ she has to take note of individual differences in the development of Mathematics concepts and skills in children. The teacher has to understand the sequence of presenting Mathematics concepts to children and relate them to the children's ages and level of maturation.

The use of concrete objects is also supported by Richard Skemp, who is also a cognitive developmental theorist. According to Tipps and Kennedy (2000), Skemp argues that in the learning of Mathematics, physical activities and manipulation of concrete objects help in the process of extracting concepts before children move to abstract thinking. Children will later develop mental associations from what they acquire at the concrete stage.

The development of concepts in children is multi-dimensional. The teacher should not focus on only one way of delivering instruction in Mathematics. The teacher has to provide a climate that allows the child to interact with the environment and peers. The teacher has to consider Vygotsky's theory of social interaction. For Voygotsky, children learn through interaction as they acquire language. In this regard the teacher has to provide for group activities that provide for interaction among children. Children also have to explore with materials in addition to interaction with peers and the teacher. Bruner's theory focuses on three stages which are enactive, iconic and symbolic. As such, the learning of Mathematics goes through these stages. They focus on the development from concrete stage to the abstract stage. In that regard Bruner has a lot in common with Piaget's theory on the teaching of Mathematics, which is important to the teacher. Thus, the teaching of Mathematics should be guided by underlining theories of teaching and learning.

The other characteristic of mathematics instruction is guided practice during learning. At ECD level the teachers is there to guide children as they learn and acquire new skills. The lesson has to be child-centred and the teaching methods used have to put the child at the centre. The teacher has to bear in mind the children's attention span. As noted by Brizuela (2004) at ECD level the whole teaching and learning process is focused on the needs, requirements, abilities and interests of the child. Larson (2002) also observes that during the lesson, children have to move from learning activities to initial practice under the guidance of the teacher. This characteristic involves the teacher giving children problems to work on. This helps to give feedback, in terms of the area children need help. This stage also involves children questions on areas that are not clear to them. The child-centred approach can make use of discovery learning. According to Charlesworth and Lind (2012) discovery learning enables children to explore and experiment with objects found in the environment and children become agents of their own learning as they become self-dependent and self-confident. For child to be able to discover, the teacher has to create a positive learning environment. This can be done by providing the necessary resources, and providing children the opportunities to explore. This helps children to learn and develop Mathematical concepts efficiently, which is the fundamental purpose of education. For example, at ECD level, at the sand and water play area children can discover on their own the number of bottles that can fill a big tin, thus developing the concepts of volume in them. They can also discover objects that sink in water, for example stones, bricks and metals at the same time discovering light things that float in water such as plastic, balls, paper and leaves thereby developing the concept of mass. They can also lift the objects and compare their mass. Activities are therefore designed to develop different concepts in the children.

The fourth characteristic of an effective Mathematics instruction is a summary or conclusion of the lesson. This characteristic enables the teacher to link the objectives of the lesson with the activities done. This can be done by the teacher asking questions. The teacher can highlight discussion points for the children. This can be through asking children to perform some of the activities they had performed during the lesson. The conclusion provides for interaction

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between the teacher and the children. Such interaction provides for feedback that is important for evaluation and future planning. Such feedback provides motivation to the children, for them to develop an interest in Mathematics.

For instruction to be effective, the teacher has to assess the performance of the children in the lesson. Such assessment is done through evaluation. Evaluation can be based on the children's activities and written work. Effective Mathematics instruction has to result in assessing the Mathematics objectives, the activities and the concepts developed. Assessment and evaluation can be formative or summative. Formative assessment takes place during the lesson. The teacher has to be assessing children's performance in relation to the objectives. This can be done through observation of children's work as they learn. This can also be done through asking questions and asking children to perform specific mathematical tasks. The teacher has to monitor children's activities and exercises during the lesson. At the same time summative evaluation comes at the end of the lesson. Both forms of evaluation provide feedback for future planning. According to Harlen (2007) assessment is critical in education as it involves collecting of evidence and judgements relating to outcomes and such judgement can then be communicated and be used.

4. EXAMINING THE ECD MATHEMATICS CURRICULUM IN ZIMBABWE

A curriculum for infants and toddlers covers the first three years of life which are critical to a child's development. Decker (1990) observes that at this stage rapid brain development takes place as children attempt to discover themselves, at the same time learning to relate with others. All activities they engage in have to contribute to emotional, social, physical and cognitive development. Bowman, Donovan and Burns (2000) are of the view that an appropriate curriculum should provide a way to build social and emotional competence as they develop concepts and acquire information and skills. For them, an appropriate curriculum has to promote the creation of an environment that creates opportunities for children to interact, explore and make choices. The focus of the curriculum has to be on how, what, and where they learn. It also has to define the role of the teacher and parent. All these processes and stages have to undergo constant review. This is necessary in order to keep abreast with modern thinking and technology in education. As noted by Brikart and Dodge (2014), a clear philosophy about how children learn requires an understanding of developmentally appropriate practice and new understandings of appropriate pedagogy. This is important as what children learn in their early stages of development has a bearing on content and skills learnt in later years (Neuman, Copple and Bredekamp, 2000).

The physical environment acts as a textbook for the curriculum and the child should be able to learn through the same environment. The role of the teacher is therefore to provide guidance, by making decisions about indoor room arrangement and out- door spaces, the appropriateness of the materials and equipment. The classroom becomes the laboratory for children to investigate, reconstruct, and share as they work with blocks, engage in dramatic play, manipulate sand and water, use table toys, explore the library, and participate in music and movement activities, explore art materials, cook, use computers and play outdoors, they learn concepts and skills in literacy, mathematics, science, social studies, the arts and technology (Dodge and Bickart, 1999). What this calls for is a child-centred approach in the implementation of the curriculum. Such an approach to the curriculum is based on a number of philosophies. The immediate philosophies that come to mind are the ideas of Jean-Jacques Rousseau and Dewey. According to Darling (1994:8), Rousseau argued that educational needs should be individualised and that nature has "implanted in the child certain instincts for the purpose of promoting development" and as such children have to develop according to their natural abilities. Rousseau's ideas on children's education have become known as the philosophy of Naturalism. It is guided by the philosophy that a child should be allowed to develop as nature intends. In a similar vein, Dewey's ideas on the curriculum also recognise the need to develop such skills as problem solving, language, and mathematics concepts through play and exploration of the surroundings.

The Zimbabwean ECD curriculum has provision for the participation of parents. For example, Director's Circular No. 12 of 2005 stipulates that School Development Committees and School Development Associations were expected to play a

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crucial role in developing and promoting the ECD programme at their schools and have to contribute towards the construction and furnishing of ECD centres and classroom. The needs of the child are best met when parents are also actively involved in the education of their children, since their participation in programmes helps them to observe firsthand the progress their children are making.

An examination of the ECD syllabus by the Zimbabwe, Ministry of Education, Sport, Arts and Culture shows four components of the syllabus. The major components of the Mathematics syllabus are key concepts that have to be developed, objectives, suggested activities and suggested learning areas and materials. The key concepts to be developed include matching objects and pictures, classification, ordering, pre-number skills, shapes, patterns, measuring, volume, money, mathematical language, and time. It should be noted that related activities focus on concept formation and development. Such activities include Mathematical play, dramatic play, music and dance, outdoor play, and discovery play. Such a curriculum makes learning a practical activity.

Both the activities and the assessment of children cater for individual differences. The children are observed as individuals and not against the performance of other children. For example, when children are working on a topic like Volume, the activities may involve pouring contents into containers with different shapes, transferring contents to containers with same volumes, but different shapes (Ministry of Education, Sport, Arts and Culture, 2012). So when it comes to assessment the teacher then indicates what the child was able to do and provide corresponding comments.

On the same note, the assessment guide focuses on whether the child was able to arrange, sort, and match objects according to shape, colour and size among other activities (ibid). What stands out in the activities and assessment procedures are the realisation of the child as an independent individual, who is not to be compared with other children. In that respect, the ECD curriculum borrows ideas from Rousseau's philosophy of Naturalism which stressed the importance of internal growth and child-centred education. The recognition that development takes place in stages and that teachers have to consider these stages when planning for children. The approach is very much in line with modern philosophies of education. These include Dewey's philosophy of Pragmatism, Existentialism, Montessori philosophy and the Highscope philosophy among others. Whilst the different philosophies might differ in their areas of emphasis, they seem to converge on the need to make the child the central player in the learning process as they recognise relevance of nature and the environment in the development of the child. In that regard, they all advocate for a curriculum that promotes active learning, personal initiatives, the development of confidence and independence of the mind.

5. LIMITATIONS OF THE CHILD-CENTRED APPROACH IN THE TEACHING OF MATHEMATICS

As noted above, the advocacy for a child-centred approach to teaching and learning is overwhelming. Despite this advocacy, traditional modes of teaching are still prevalent in Zimbabwe at all levels in the education system. Arguments have been advanced suggesting that some teachers need in-serving in order for them to align their teaching to the new paradigm in education. Apart from the suggested in-service training of teachers there have been indications that suggest the change of the school curriculum in order to cater for individual differences in the development on children at school. Such curriculum innovation should also cater for teacher education at teachers' colleges and universities.

As noted earlier, the teaching of mathematics involves the development of concepts. At the ECD level this can be done as children explore objects. The focus of the mathematics lesson should help children to form concepts through experience, interaction with others and proper guidance from teachers and parents (Seefeldt and Barbours, 1986).

On the Curriculum, Neuman et al (2000) suggests six strategies that help teachers on making decisions about their work with children. These strategies are; know the children, creating a classroom community, establishing a structure, guiding children's learning, assessing children's learning and building a partnership with families (ibid).

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6. THEORIES THAT CAN GUIDE THE TEACHING OF MATHEMATICS

A number of theories have been used to explain cognitive development in children. These include theories by Skinner, Bruner, Vygotsky and Piaget among others. These help us to understand how children acquire and develop concepts in mathematics. In this section we revisit Piaget's theory in detail to explore how it can guide the teaching and learning of mathematics at ECD and primary school levels.

In his theory of cognitive development, Piaget classifies development into four different stages. The first stage is the sensorimotor stage. This stage is the infancy stage and covers the ages from birth to two years. The second stage of cognitive development according to Piaget is the preoperational stage which covers the age groups 2 years to 7 years. The other stages are the concrete operational stage (7 to 11 years) and the the formal operations stage (11 to 12 years and above). The importance of these stages is how mathematics concepts are learned and developed in children at each of these stages. At the sensorimotor stage the child uses motor and reflex action to explore the environment. This is done through touching and sucking objects. The preoperational stage (2-7 years) is characterised by visual images that enable the child to comprehend the concrete environment. To help the child develop mathematical concepts the use of symbols, and classification of objects have to be emphasized. As such, activities in the classroom have to include tasks that promote conservation. As noted by Bergh and Theron (1999) activities should involve conversation of quantity, length, area, number and weight. Conservation is the ability to think logically. Such thinking involves giving the child an opportunity to determine how a certain quantity will behave when there are adjustments of the container, shape, or apparent size. According to Hook, Watts, and Cavanaugh (2007) development at this stage is characterised by the one to one principle, the stable order principle, the order irrelevance principle, the cardinality principle and the abstraction principle. The principles above focus on how children learn numbers and counting. As noted by Gelman and Gallistel (1978) the one-to-one principle emphasizes the idea of partitioning and tagging. This involves assigning one counting tag to each object in the array, whereas the stable order principle involves arranging objects in repeated order. Such practices help children in the development of numeracy and understanding of relationships. Other activities may include the use of counting songs, comparing and matching objects.

Gelman and Gallistel (1978) note that cardinal principle reflects the children's understanding that demonstrates that the last number word of an array of counted items has a special meaning as it represents the set as a whole. They further note that in the abstraction principle the child has to be made to realise that counting can be done to mixed items. At the same time the order-irrelevance principle, as the term implies demonstrates that the order of counting as children develop an understanding of numbers becomes unimportant.

The principles referred to above are important in the development of conservation. They remind us of the need to move away from the traditional approach to teaching and learning mathematics. As noted by Goodrow (1998) the traditional approach focuses on the acquisition of basic numerical skills such as number order and counting, addition and subtraction facts among others. Focusing on these alone in mathematics may promote memorising of mathematical facts which restricts mathematical thinking.

The concrete operational stage covers the 7 to 11 years. This is referred to as late childhood stage. At this stage learning is characterised by logical thinking and learning through direct experience. Children learn by performing activities that help promote the use of logic and mental operations.

According to Piaget the fourth stage of cognitive development is the formal operation. This stage covers the 11 years to 12 years old and above. The activities at this stage have to promote reasoning. Hook et. al (2002) observes that formal operational stage is characterised by at least four forms of reasoning that have to be promoted in children. These are propositional reasoning, hypothetico-deductive reasoning, proportional reasoning and combinational reasoning. The key issue in the teaching of mathematics is coming up with activities that develop these different forms of reasoning.

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Children need opportunities to express themselves in different forms that promote reasoning in the classroom. The emphasis is therefore on activities that promote development in each of the development stages that were advocated by Piaget in his theory of cognitive development. Such activities include discovery play, problem solving, experimentation, mathematical play, manipulative and block play. These activities contribute to the development of skills such as logic, imagination, decision making, application, synthesis, analysis, evaluation, perception, and creativity among other relevant skills. As stated by Gatsi, Mamvuto, Tafirenyika (2012), the teacher has to provide varied materials, tools and equipment that are familiar to children's experiences, at the same time providing hands on experiences that make teaching and learning child centred. In addition to this the teacher is expected to organise field trips. Kasambara (1995) refers to field trips as a learning activity that is done outside the physical school environment which enables children to have a real life experience. That experience is essential in promoting learning not only in Mathematics, but other subject areas and as such children can have an integrated approach to learning.

7. CONCLUSION

The paper focused on five characteristics of a balanced Mathematics instruction at ECD level and primary school level. Guided by the theories of learning from different psychologists, the paper discussed the following characteristics; introduction, development of concepts or skills, guided practice, summary and evaluation. The paper also examined these in relation to the role of the teacher in teaching and learning. The need to advocate for an improvement in the teaching of mathematics cannot be overemphasized considering the low performance in mathematics public examinations and the demand for mathematics skills globally. The paper also examined components of the ECD curriculum in Zimbabwe. To discuss the mathematics curriculum, the paper had to consider the views and philosophies of great philosophers like Dewey and Rousseau whose ideas now influence the design and implementation of the curriculum in modern education. It also discussed Piaget's theory of cognitive development in relation to the role of the teacher in the teaching of mathematics. It can be concluded that for a teacher to be effective at teaching mathematics at ECD level and primary school level he/she has to be aware of the theories that guide child's learning and that teaching and learning have to be child-centred. At the same time, the teacher has to realise that learning is a process that has to follow a sequence according to the children's ages and stages of development.

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